Author: Hussain, S.T.
Title: The French-Anglophone divide in lithic research: A plea for pluralism in Palaeolithic Archaeology
Issue Date: 2019-03-14

THE FRENCH-ANGLOPHONE DIVIDE IN LITHIC RESEARCH

A PLEA FOR PLURALISM IN PALAEOLITHIC ARCHAEOLOGY

SHUMON T. HUSSAIN

The French-Anglophone divide in lithic research

A plea for pluralism in Palaeolithic archaeology

Proefschrift

ter verkrijging van
de graad van Doctor aan de Universiteit Leiden,
op gezag van de Rector Magnificus prof. mr. C.J.J.M. Stolker,
volgens besluit van het College voor Promoties
te verdedigen op donderdag 14 maart 2019
klokke 11:15 uur

door

Shumon Tobias Hussain

geboren te Ostfildern, Duitsland
in 1987

Promotor: Prof. dr. R.H.A. Corbey (Universiteit Leiden)

Promotor: Prof. dr. M. Soressi (Universiteit Leiden)

Co-promotor: Dr. K. Vaesen (Technische Universiteit Eindhoven)

Promotie commissie:

Prof. dr. W. Roebroeks (Universiteit Leiden)

Prof. dr. C. Perlès (Université Paris X-Nanterre)

Prof. dr. P. van Peer (KU Leuven)

Prof. dr. J.C.A. Kolen (Universiteit Leiden)

Dr. A. Verpoorte (Unversiteit Leiden)

The research presented in this dissertation has been generously funded by a scholarship of the *Studienstiftung des Deutschen Volkes*.

I dedicate this dissertation to my parents – Gabriele and Altaf – for their enduring support, trust, and love.

In memory of Saskia, Heide, and all others who left this world too early…

Index

Extended table of contents

List of boxes

List of figures

List of tables

Key notions

The designations **French** and **Anglophone**, as used in this study, signal primarily socio-intellectual affiliations. Scholars attributed to either of the two spheres of research are entangled with the institutional landscape in France or the United States of America (US) and Great Britain (UK), they do not necessarily hold a French, US, or UK passport, however. This entanglement, although typically rooted in the early academic education of the respective practitioners, can be purely discursive (see **Appendix I.1**). Hence, classic 'discourse analysis' is generally capable to provide an entry point to characterising and unravelling the enigmatic French-Anglophone divide in Palaeolithic archaeology – the subject of the present investigation.

Lithic research is understood pragmatically in this study. It comprises all scholarship that pays attention to the analysis of stone tools from the Palaeolithic period. The focus lies on the empirical analysis of lithic technology, including its theoretical and methodological background, and not so much on matters of excavation and field research. Key figures are primarily identified based on their contributions to the theoretical and methodological development of the field. This evaluation is based, firstly, on a detailed survey of the dynamics characterising the history of research in France, the US, and the UK and, secondly, on a sociological study of relationships between scholars as well as between scholars and research institutions (see **Appendix I.1, I.2, III.4**). As the following examination will ultimately disclose, lithic research is differently conceptualised and understood across the French-Anglophone divide.

Introduction

Is archaeology a science or is it art?
"Neither – it's a vendetta."

– Mortimer Wheeler

"What you find, archaeologically, has everything to do with what you look for with the questions you ask and the conceptual resources you bring to bear in attempting to answer them. And yet, you almost never find all or only what you expect."

– Alison Wylie (2002: xiv)

I hope that this dissertation will be of relevance for a variety of readers. It is written primarily for Palaeolithic archaeologists but may also be of interest to other scholars fascinated by the stone tools left behind by the species of hominins that once populated the earth, some of which were our ancestors. This study also addresses longstanding philosophical issues that arise when researchers interrogate these ancient stones in the hope of enriching our knowledge about the deep past. The dissertation may therefore also speak to philosophers of science and other observers of scientific practice, as long as they are interested in the conceptual foundations of the empirical endeavour of stone tool analysis, with its specific interpretive problems and discursive preoccupations. The goal of the investigation therefore follows from its nature. On the one hand, I hope to elucidate the conceptual structure of current lithic research in order to ignite new avenues of inquiry and to contribute to a more self-reflexive attitude among Palaeolithic archaeologists. On the other hand, I aim to show that lithic inquiry provides an interesting example of 'science in practice,' where practices and interpretations regularly clash and knowledge is constantly re-negotiated. The structural dynamics that drive this process are the subject of this study.

The investigation covers a range of interconnected themes but its main focus lies on what I term the 'French-Anglophone divide.' This divide, particularly well-developed in lithic studies, results from divergent cognitive orientations propelling French and Anglophone research traditions in Palaeolithic archaeology.[1] As shown in great detail in this study, the two research traditions have developed distinct cognitive resources, and, as a consequence, often antagonistically handle the lithic evidence available to them. The result is a pervasive climate of methodological and interpretive friction, in which the very same lithic materials may be used to supply contrasting knowledge claims. The situation resonates with Bruce Trigger's (2003: 1) symptomatic note that "[a]rchaeology might have been invented as a case study for the philosophy of science [...]" since "[t]he paucity of evidential constraint renders [it] a very revealing example of how data are interpreted by social scientists."

Three cases of interpretive conflict may illustrate this general condition of lithic research in Palaeolithic archaeology. The first case concerns the lithic assemblage from level IIA at the open-air site Biache Saint-Vaast in Northern France. This assemblage, often considered a key instance of early Levallois technology, has sparked some controversy on method and interpretation in lithic research since the initial analysis by French technologist Éric Boëda (1988) yielded a radically different result than the subsequent re-investigation of the same assemblage by American archaeologist Harold Dibble (1995a). The second case concerns the level G assemblage from Gouzeaucourt, also situated in Northern France and dating to the Lower-to-Middle Palaeolithic transition. Its bifacial component has been interpreted in incompatible ways by Shannon McPherron (1994) and Sylvain Soriano (2000) in their

[1] For a definition of these notions in the problem-context of this study, consult **Appendix I.1**.

doctoral dissertations. The third case of illustration, finally, concerns the Micoquian of Kulna cave with its combination of bifacial and discoid technology, which became the subject of similarly divergent inquiry by Éric Boëda (1995a) and Gilbert Tostevin (2000, 2012). These interpretive disparities are far too substantial to be explained by the deployed research designs, methodologies, and research questions. In fact, the disparities seem to be rooted in incompatible conceptualisations of lithic data themselves and appear to derive from a conflicting understanding of the basic observational and interpretive categories used to interrogate the available evidence.

How, then, do we explain such divergence? How to deal with a situation in which scholars seem to make contradictory sense of the very same lithic assemblages? What are the implications for lithic research at large? Can we just keep going, hoping that one day the difficulties will resolve themselves? The available expert literature is at least not helpful here. There seems to be either baffling perplexity, or open ignorance when these and cognate issues are raised. Yet, such problems are arguably central to the field and its future development. If we cannot grasp what is going on in these paradigm cases, it only proves how little we know about what we do; this, in turn, may be a dangerous, or at least 'unsettling,' situation to be in. For it can be argued that proper knowledge is only possible if transparency can be established in terms of how particular insights have been generated and why they conflict with competing knowledge claims.

This study is an attempt to respond to these concerns and provides an in-depth analysis of the French-Anglophone divide. It reveals the substantive nature of the latter and clarifies its sources. The hope is to dispel the myth of a relative unity of lithic approaches in Palaeolithic archaeology once and for all. Lithic research faces similar problems as other fields of inquiry, albeit these problems of course effect lithic knowledge production in highly specific ways. Having said this, the French-Anglophone divide showcases a total bifurcation of the research landscape, with research varying on almost all levels of inquiry – testifying to 'two cultures of science' (*sensu* Snow (1998 [1959]) and attesting to a cherishing of distinct 'cultural politics' (*sensu* e.g., Shanks 1992: 2).

Although this characterisation seems to primarily accentuate the negative aspects of the divide, it also holds tremendous promise. The divide affords a range of possibilities for practitioners to broaden their conceptual horizon, to become inspired, and to learn from the issues at stake. Ironically, the careful examination of the French-Anglophone divide can therefore help *improve* the interrogation of the lithic evidence and to suggest new research avenues! I can only stress that exploring the epistemology of the divide is thus not a self-sufficient enterprise. Rather, epistemological and empirical questioning can and arguably should cross-fertilise each other. Put differently, the analysis of particular scientific practices has considerable potential to *enhance* these practices. Ultimately, it is in this respect that the present work seeks to make an original and lasting contribution.

A brief outline of the argument

The key argument developed in this study is that the nature and structure of the French-Anglophone divide can be considerably clarified by drawing on the concepts and categories introduced by American philosopher Stephen C. Pepper in *World Hypotheses* (1942). Proceeding from Pepper's insights, it can be proposed that central axes of divergence between French and Anglophone lithic inquiry may be the result of a reliance on different sets of world hypotheses. Such world hypotheses encapsulate basic assumptions about the structure and nature of reality and turn out to be the prerequisite of gathering and digesting empirical evidence. I argue that the difficulties of interpretation and communication that arise at the French-Anglophone interface are connected to the more general struggle of consolidating 'analytic' and 'synthetic' science: French technological research fosters 'synthetic' inquiry – i.e., the view that wholes delineate the primary units of analysis – whereas Anglophone approaches cultivate 'analytic' modes of investigation – i.e., the view that parts make up these primary units of analysis. How lithic research is conducted on both sides would seem to be a direct consequence of this organisation. Pepper further exposes that 'analytic' and 'synthetic' research supply different sets of world hypotheses: the former has given shape to 'formism' and 'mechanism,' the latter harbours 'contextualism' and 'organicism.' My contention is that these two sets of two world theories can be shown to power the French-Anglophone divide, explaining both its 'DNA' and its practical symptoms.

How do these various standpoints relate to each other? Pepper's work elucidates that the four world hypotheses represent equally adequate yet irreducible modes of knowledge production. There is an epistemological symmetry between these viewpoints. Any attempt to elevate a single perspective above all others must consequently remain dogmatic. What are the implications of this state of affairs? Can one with clear conscience discard any of the perspective sponsored by the four world hypotheses? I maintain that one cannot. The only reasonable solution is to acknowledge the fundamental pluralism that permeates the French-Anglophone boundary, and *a fortiori* lithic research as a whole. Each world theory inaugurates standards of research not shared or supported by any other theory. For this reason, I content, it is imperative to recognise and expose these varying standards of knowledge production if we wish to navigate and productively bridge the divide.

The resultant disunity of lithic research, even though introducing some important caveats in how scholars can effectively interact, ultimately offers an advantage to lithic practitioners, who may quite literally learn from 'other' worlds of thought and profit from the unique resources and capacities put forth by the attendant ways of knowing. Taking all adequate viewpoints into account would place lithic research onto a much broader and ultimately firmer empirical basis. Yet, an important shift in emphasis would be required. Rather than regarding the French-Anglophone boundary as an obstacle to successful knowledge production, we should regard it as a meeting point of two broadly complementary yet irreconcilable groups of approaches, having the potential to cooperate in the quest for lithic knowledge in hitherto unconceived ways. It is only possible to appreciate this 'productivity of epistemological diversity' if one embraces the autonomy of the four cognitive orientations that participate in the divide. I therefore maintain that the French-Anglophone boundary strongly calls for the abandonment of knowledge 'monism' in Palaeolithic archaeology – the idea that for every valid scientific question there can only be one valid answer and one best method or practice to achieve it. From this perspective, the divide provides tangible evidence suggesting that a plurality of scientific viewpoints in fact *enriches* lithic discourse and knowledge, rather than curtailing them.

The structure of the dissertation

The dissertation is divided into six individual chapters that differ somewhat in scope, but each contributes in a well-defined manner to the argument. I begin with an outline of the problem of lithic knowledge and a preliminary survey of the French-Anglophone divide. I then develop the concepts and categories needed to analyse the logic of the divide in more detail. Subsequently, the resulting conceptual apparatus is applied to selected cases of French and Anglophone lithic research. Finally, the findings of this examination are confronted with the initial formulation of the problem and evaluated in terms of their significance for the question of pluralism in lithic inquiry.

Chapter 1 introduces the problem of lithic knowledge in Palaeolithic archaeology, which relies on a fragmented and often mono-specific record dominated by lithic remains. A pragmatic definition of lithic knowledge is proposed and it is shown that this knowledge is crucial for understanding the Palaeolithic as a whole – it carries a heavy burden. The nature of evidence from the Palaeolithic including its scarce supply create a temptation to populate dogmatic positions. This situation aggravates the problem of the underdetermination of interpretations by data. Together with the social dynamics of knowledge formation within research communities, this condition easily subverts the ability of scholars to envision or consider alternative readings and thus to properly gauge the global status of particular knowledge claims. The second part of Chapter 1 provides a concise overview of what has been written about the French-Anglophone divide. There appears to be a general consensus that French and Anglophone lithic approaches deviate in method and theory, but opinions greatly diverge as to the nature and significance of these differences. It is clear that the respective incompatibilities have generated much tacit hostility and latent misunderstanding. The 'Binford-Bordes debate' is shown to be a crucial yet often misunderstood historical forerunner of the divide. Furthermore, it is documented that the critique directed towards the respective 'other' is equally devastating for both sides (although the topic is treated somewhat asymmetrically). I then introduce the three comparative case studies already alluded to in order to argue that underdetermination not only plays a role in theoretical and methodological battles, but has tangible consequences for how individual lithic artefacts or entire assemblages are understood. The chapter concludes with some reflections on the status of what I term 'critical practice' in the field.

Chapter 2 establishes the epistemological framework of the conceptual analysis that follows. It introduces Pepper's 'world hypotheses theory' as a viable lens through which to study underdetermination in lithic research. The chapter provides an overview of Pepper's relevant work, focussing on his proposition that Western thought can be collapsed into four equally adequate cognitive orientations: 'formism,' 'contextualism,' 'mechanism,' and 'organicism.' These four orientations – the 'pillars of Western cognition' – rest on distinct 'root metaphors,' derived from common-sense experience and constantly refined over the course of intellectual history. Each cognitive orientation supplies a different canon of structural categories, regulating how the available evidence is interpreted and criticised. This cognitive architecture is highlighted in detail since it delivers the analytical categories used in the consecutive chapters to examine particular instances of lithic research – it begs the question of the standpoint, i.e., the nature of the cognitive access of the analyst to the evidence. Subsequently, I survey the relationships and dynamics between the four world theories and demonstrate that they not only differ in their conceptual logic, but also in how they criticise knowledge claims and secure what they regard as scientific 'truth.'

Chapter 3 presents a general application of Pepper's world theory framework to the French-Anglophone divide. The divide is interpreted as the outcome of the conflict between two antagonistic visions of science: Anglophone lithic approaches tend to subscribe to an 'analytic' project of knowing, whereas French lithic inquiry gravitates toward a 'synthetic' understanding of the lithic record. This hypothesis is then tested and discussed in the remainder of the chapter by analysing some of the key coordinates of the divide. I examine and compare practices of lithic recording, adopted research designs and the applied logic of inference, the role of theory and data, and the dominant practices of lithic visualisation. Does the divide indeed conform to a clash of 'analytic' and 'synthetic' science? I provide a first answer by analysing the principal notions of variability and complexity on both sides in terms of the basic structure of the 'analytic'-'synthetic' opposition.

Chapter 4 takes a closer look at the 'analytic' nature of Anglophone lithic inquiry. The main question is whether Anglophone approaches reflect 'formistic' and 'mechanistic' convictions respectively. In other words, can Pepper's respective world theory categories be productively applied to prototypical occurrences of Anglophone lithic research? In order to answer this question, the chapter introduces seven selected case studies of varying focus and examines them in detail. The first part of the chapter unmasks four cases of 'formistic' knowledge production, whereas the second part investigates the 'mechanistic' legacy of Anglophone research traditions by drawing on three lithic case studies. The chapter demonstrates that the core of the Anglophone research endeavour is built around 'formistic' and 'mechanistic' conceptualisations of how the lithic evidence 'hangs together'!

Chapter 5 examines the 'synthetic' nature of French lithic inquiry by reconstructing some of its key strands in terms of the structural categories issued by the respective world theories. Can these prototypical French approaches be shown to rely on 'contextualistic' and 'organicistic' assumptions and concepts? The chapter draws together seven selected case studies to provide an answer to this question. The first part of the chapter highlights four cases or aspects of 'contextualistic' inquiry in the French scene, whereas the second part enumerates three cases of lithic research which are committed to 'organicistic' concepts. The analysis shows that French technological research is characterised by the tension and interaction between 'contextualism' and 'organicism.'

Chapter 6 reviews the main findings of Chapters 3 to 5 and explores their implications. It sheds new light on some of the long-standing issues created by the divide, for example the problematic relationship between *chaîne opératoire* and 'reduction sequence' approaches. The chapter makes a strong case for the irreducibility and equipotency of the four cognitive orientations lying at the heart of the divide. It shows that the parallelisation of the French-Anglophone boundary with the 'analytic'-'synthetic' polarity of world theories leads to the recognition that, in principle, no side can claim cognitive superiority. Lithic research is argued to be fundamentally *pluralistic* to this effect. I draw out some consequences of this condition for practices of criticism at the French-Anglophone interface. It is contended that critique can only be successful and productive if the cognitive standards under which particular knowledge claims have initially been generated are taken seriously and are respected to some extent. By reviewing the main lines of mutual criticism gathered in Chapter 1 in this light, I conclude that the type of 'signature critique' currently deployed by both sides often turns out to be counterproductive and must thus be re-considered if a serious *rapprochement* is envisioned. The chapter closes with some thoughts on the overarching complementarities between the four cognitive orientations and the potential for future cooperation between the two factions of lithic knowledge production. Taken together, a key insight is that lithic research can improve its own practice by cultivating a self-conscious and self-critical attitude in terms of its basic epistemological commitments.

Some leads and suggestions for readers

Since this study is potentially of interest to various audiences, a few words on preferable reading approaches may be useful. Most archaeological readers, especially those not so much interested in conceptual details and technicalities, are advised to primarily consult Chapters 1 and 6. From there, one can easily go back to some of the selected details presented in Chapters 3 to 5. The latter chapters should consequently be of primary concern to anybody interested in the conceptual underpinnings of stone artefact analysis and the intricate relationship between different lithic approaches and Pepper's four world hypotheses. Even though it should in principle be possible to understand the basic message of Chapters 3 to 5 without consulting Chapter 2, archaeological readers are at least encouraged to inspect the various info-boxes found in this chapter; these concisely outline the core features of each of Pepper's four cognitive frameworks. The info-boxes are designed to guide readers through the specialised terminology encountered in Chapters 4 and 5.

The core parts of interest for philosophy of science-oriented readers are Chapters 1, 2, and 6. Chapters 3 to 5 may be consulted selectively and according to individual preference after these core parts have been taken into account.

For obvious reasons, it is recommended that all readers, irrespectively of their background, carefully engage with Chapter 1, which sets up the basic issues and introduces the French-Anglophone divide in some detail. Moreover, readers especially interested in the various aspects discussed in Chapter 3 are encouraged to take into consideration the thorough juxtaposition of the three paired lithic case studies at the end of Chapter 1 before they start reading.

Supplementary information can be found in the Appendices. Appendix I clarifies the notions 'Anglophone' and 'French' with regard to their utilization in the present research and discusses the criteria of selecting the three paired case studies, including what one can learn from them. Appendix II sketches some methodological aspects of using Pepper's world hypotheses as a conceptual framework to study scientific practice and comprises a discussion of the conceptual shortcomings and potential inadequacies of each of the four world theories; it also stores additional information on the *layer*- and *pound-cake* model of cultural reality, which are referred to time and again in Chapters 3 to 5. Appendix III contains the supplementary information for Chapters 3 to 5. It for example presents additional schemes of inference including an outline of the methodological procedure underlying their construction and the exposition of the general rationale which has guided the selection of the analysed cases in Chapters 4 and 5. Appendix Q, finally, lists all original French quotes which are given as English translations in the main text.

Since the present study has to deal with two, and sometimes three languages, original terms – where possible – are provided in parentheses. Round brackets are reserved for English and French, the two main languages under discussion, while German terminology – if useful – is given in square brackets. Original French terms which are non-commonplace[2] or important to highlight are distinguished by the use of « ».

Finally, critical readers and those that find themselves in a position where many basic questions appear to have been unanswered are warmly invited to examine the FAQ section which has been included following Chapter 6. This section anticipates elementary questions as well as likely angles of criticism and reacts to them, showing that most of them are misconceived. Some readers may therefore want to to refer to this section as soon as possible, for example immediately after reading Chapter 1, in order to dispel their early scepticism and to warrant their further engagement with the present analysis and its findings.

[2] For example, the term *chaîne opératoire* is common-place – i.e., regularly used in the English expert literature – while the term « *Paléohistoire* » is certainly not.

Chapter 1

The clash of French and Anglophone lithic research in Palaeolithic archaeology[3]

> "[…] *The second temptation* [of human science] *may be referred to as "esotericism." It distances itself from the order of realities substituting the latter with a logical construction, a complex edifice of categories, principles, notions and concepts which are only accessible by initiation. The logical tie between them is then postulated to be identical with the logic of the real; the order of things matters less than the order of words. And the criteria of acquiescence eventually become those of faith, more than those of scientific reason. This realised temptation transforms scientific schools into chapels or sects, controversies into scholastic debates, and doubts into heresies.*"
>
> – Georges Balandier (1974: 7f.; my translation)

Abstract

This chapter introduces the problem of lithic knowledge and the French-Anglophone divide in Palaeolithic archaeology as one of its key venues. In the first part of the chapter, a general outline of lithic knowledge is provided and some of the most pertinent issues that scholars face when attempting to secure it are discussed. It is argued that lithic evidence, although one of the most reliable sources of knowledge of the Palaeolithic, remains critically fragmented and patchy. The sparse supply of evidence available from this period renders lithic knowledge claims vulnerable to underdetermination. This situation, in turn, greatly incentivises researchers to resort to dogmatic positions. The problem is generally aggravated by the social heterogeneity of lithic research. Different research communities tend to cultivate distinct styles of reasoning and respond to similar problems in different ways; lithic knowledge claims are susceptible to what may be called the social tenacity of viewpoints. The second part of the chapter shows, firstly, that the French-Anglophone divide can be reconstructed as a clash of two larger research communities harnessing vastly different cognitive resources. Three pairs of case studies, secondly, demonstrate that the very same lithic assemblages continue to be interpreted in incompatible ways by representatives from both sides – a further indication that lithic knowledge claims are critically underdetermined by the lithic data. The chapter concludes that the French-Anglophone divide has to be taken seriously and that discussing it as just a problem of data, method, or theory is likely insufficient. Instead, we must be more reflexive about the epistemological foundations of lithic research that produce the divide. Such reflexivity requires a re-consideration of what I call 'critical practice' in the field.

1.1 The problem of lithic knowledge

The present chapter addresses pertinent questions of lithic knowledge that arise at the French-Anglophone boundary, when practitioners from both camps examine knapped stone technology and assess its value for interpreting the Palaeolithic past. In this first section, the nature of lithic knowledge will be discussed and some of its epistemological ramifications exposed. This portrayal will both establish why an epistemological treatment of the topic is mandatory (and in fact long overdue) and lay the groundwork for the in-depth conceptual analysis to follow in the subsequent chapters.

---

[3] For the original French version of the introductory quote, see **Appendix Q.1**.

1.1.1 ***A pragmatic definition***

Knowledge can be defined in many ways.[4] The same is of course true for 'lithic knowledge.' What can count as knowledge arguably depends on the context of research and the accepted standards of inquiry. Counteracting research agendas often adopt quite different concepts of knowledge. As a result, any clear-cut, substantial, prescriptive, or 'normative' definition of knowledge, and by implication 'lithic knowledge,' tends to be compromised from the beginning. The concepts of knowledge brought to bear in Palaeolithic archaeology are theory-laden to the same extent as other tokens of research (cf. Collins 1999)[5]:

> "Facts, or rather observations of data, are never simple. Neither are they neutral or value free. Facts are theory laden. They cannot be read objectively but come ready interpreted, owing to such factors as the history of the subject and how they have been interpreted within the narratives we use. The archaeologist does not so much breathe life into them by, say, placing pots in a battleship curve […] or analysing animal bones as evidence of how a prehistoric butcher made decisions, but rather his or her interpretation is already driven by theory, however implicit and unrecognised." (Gamble 2001: 9)

What Gamble observes for archaeological 'facts' similarly applies to archaeological 'knowledge'; the relationship between the former and the latter is reflexive. His observation is also a timely one. As we shall see more clearly in the subsequent chapters, knowledge can indeed only be understood if the foundations of practices that produce it are taken into account. Refraining from any clear-cut or substantial definition of archaeological knowledge does therefore not imply to erode the very concept. Rather, the issue of knowledge is placed on the table of empirical investigation again, positing that knowledge can be studied as a real-world phenomenon – by examining how different archaeologists relate to it through their practices and theories.

Having said this, a more pragmatic definition of 'lithic knowledge' can help to situate the discussion. Broadly speaking, lithic knowledge is a subspecies of archaeological knowledge. The latter is characterised by a unique reliance on 'material evidence' (e.g., Wylie and Chapman 2015). The material evidence that is accessible to archaeologists may be only a part of a more extensive but unknown material context; this is because the availability of archaeological evidence naturally depends on its survivability (Collins 1999: 94, 102). Archaeological knowledge rests exclusively on materials which succeeded to *survive* into the present (cf. e.g., Renfrew and Bahn 2012 [1991]: 49, 53f.; Gamble 2001: 67-72; Lucas 2015: 314). The specificity of archaeological knowledge is that it is 'without alternative' – it cannot be attained by any other means than questioning the material evidence gathered from excavations (Boissinot 2011: 301).[6] There are only two general categories of archaeological evidence – 'objects' and 'features.'[7] The first category is typically subdivided into 'artefacts' (human-made or human-modified objects) and 'ecofacts' (objects fashioned or modified by non-human forces); the second category covers the various configurations of objects (e.g., scatters, assemblages, sites) as well as the situated contexts of their discovery (e.g., layers, pits). Simply put, archaeological knowledge may arise if these sources of evidence are interrogated in maximally informative ways.

Analogously, we can hold that 'lithic knowledge' is a product of effectively examining the disposable 'lithic evidence,' which is simply defined as the totality of 'material evidence' to do with lithic artefacts – that is, human-fabricated stone objects. To this effect, lithic knowledge claims pertain to a

[4] Cf. Gibbon (2005: 68f.) for a very brief survey of the issue of 'knowledge' and 'justification' in archaeology.

[5] In his textbook discussion of the nature of archaeological data, Collins (1999: 87) confidently notes: "All data are biased: they have to be used and 'read' with care, and we cannot accept them at face value. It is this problem which is the major theme of this chapter."

[6] An underrated but crucial peculiarity of archaeological knowledge is that it rests on a document – the excavation site – which is essentially destroyed during its investigation. Some scholars have even argued that archaeological knowledge is produced by means of a series of 'unrepeated experiments' (cf. Barker 1977: 12; but see Bradley 2015 for a more nuanced view). In general, this process renders archaeological evidence fragmentary in a dual sense: not only is it a fragment in and of itself but it is also actively fragmented by practices of excavation – the bulk of archaeologically available material evidence represents literally a 'left-over' of excavating a site.

[7] Although it does not matter too much for the present argumentation, this point is admittedly somewhat contentious. Scholars do not always agree on the primary evidentiary categories that make up the archaeological record. Philippe Boissinot (2011: 267, 2015) for example discriminates between three major categories – 'stratigraphical units' (which he further subdivides into 'positive' and 'negative' entities), 'finds' or individual 'facts' (*faits*), and 'aggregates' (*ensembles*). Collins (1999) distinguishes between 'individuals' (artefacts and ecofacts), 'contexts,' 'features,' 'structures,' and 'sites.' For a general discussion of the features making up the 'archaeological record,' see Patrik (1985).

fragment of a fragment. They are harbingers of the notoriously incomplete nature of the archaeological record. Lithic knowledge is obtained from a particular inorganic source – knapped stone artefacts – and based on only a subset of the potentially available archaeological evidence. At the same time, however, lithic evidence tends to be readily available and can be developed rather reliably because its material base is extremely durable and preserves even under unfavourable conditions. Yet this advantage is also a burden.

Especially in Palaeolithic archaeology which effectively begins with the emergence of the first stone knapping technologies in human evolution, lithic artefacts are often the only remains to have withstood the exertions of time. The reconstruction of the Palaeolithic past, like no other period in human history, thus invariantly depends on interpreting the lithic record. It is mainly through the lithic evidence that we can come to an understanding of this early yet crucial epoch of human becoming, rendering lithic knowledge almost automatically a contested arena. Lithic knowledge, like no other vector of archaeological judgement, seems to legislate about our basic image of the Palaeolithic as a period, legitimising certain narratives while deprecating others:

> "If, thanks to [archaeology], we know of prehistoric man some aspects of her/his physical appearance, of her/his economic, artistic or religious life, it is mainly from the angle of the tool manufacturer that the human of this time is revealed to us. Very often, only knapped stone is preserved and testifies to the former presence and activities of a human group. As a result, the stone tool acquires a considerable value in many areas of prehistoric research." (Perlès 1974: 816; my translation [for the original French quote, see **Appendix Q.2**])

This unique reliance on lithic knowledge has motivated students of the Palaeolithic to develop an entire phalanx of theories and methods for grasping the significance of ancient stone artefacts. The result is that we now know a great deal about them, but this knowledge is often disparate and contradictory. Although the nature of the Palaeolithic record has clearly put the problem of lithic knowledge centre stage, conflicting knowledge claims are difficult to resolve and are often merely juxtaposed – most attempts to constrain or narrow down the interpretive space of lithic analysis remain equivocal or even controversial. Since the lithic evidence weights so heavy, disagreements in interpreting the lithic record may easily feed into questions of scholarly authority. The question, then, is not merely what to do with divergent lithic viewpoints but becomes a question of what to do with inconsistent visions of the Palaeolithic as a whole. The stakes of lithic knowledge are high for this reason alone.

1.1.2 *The dogmatic temptation*

Although lithic knowledge appears to be contentious, stone tools are extremely 'tangible' and promise a 'vivid' portrayal of the circumstances and activities of the distant past they embody. Before anything else, lithic objects are *realia* – i.e. concrete rather than abstract objects. As such, the mode in which they enter the arena of scholarly investigation is characterised by 'immediacy' and 'concreteness;' studying lithic artefacts and generating lithic data typically implies to interact directly with material objects. It is this *materiality* of the lithic evidence that stands out the most, pledging to provide first-hand insights into otherwise impalpable ways of Palaeolithic life. Despite the fact that stones cannot speak, the merit of lithic objects is that they presumably 'objectify' the past, by literally 'casting it in stone' – in ways that other sources, especially written texts, could not; it is their ostensible 'banality' as well as their 'casual' and 'mundane' character that seems to solidify their evidential authority. Lithic artefacts supposedly lack an agenda of their own.

This positive characterisation of the lithic evidence is counterbalanced, as we have seen, by its status as a fragment. The latter perspective often dominates the expert literature and captures how stone tools are usually conceptualised. They are seen as 'vestiges,' 'traces,' 'residues,' 'remains,' or, more rarely, 'relics' of long-deceased human lifeways. All of these terms emphasise the partiality of lithic knowledge and again call attention to the frustrating scarcity of evidentiary supply in the Palaeolithic. The circumstance that lithic evidence in this period is sparse is not so much implicated by the character of the evidence itself, but rather a consequence of the nature of the Palaeolithic record, often offering only a handful of well-excavated sites per relevant spatiotemporal segment. This situation not only calls into question the representativeness of the available information, it prompts the critical issue of 'negative' evidence. For if the record is notoriously incomplete, the 'absence of evidence' is generally difficult to interpret as 'evidence of absence,' let alone in every single case (e.g., Collins 1999: 89). Each novel discovery may change the picture fundamentally. Palaeolithic archaeologists, therefore, must face an evidentiary reality in which the irresolvable 'incompleteness' of evidence threatens to undermine the security of lithic knowledge claims and forces practitioners to retreat to the 'positive' facts.

This retreat to the 'positive' and presumably most 'impregnable' lithic facts predisposes the idea that interpretative options are limited at best, putting practitioners into a difficult position to gain substantial knowledge. Palaeolithic archaeologists, like no other group of their kind, are kept busy by the need to brace or deflect *epistemic deficiency*. This focalisation of the predicaments to render lithic evidence intelligible or significant orientates research primarily towards the inherent dangers of interpretation rather than its possibilities. The result is a condition of inquiry in which both over- and misinterpretation are greatly feared. Collin's (1999: 129) alerting reminder that "[a]rchaeological data have enormous potential for interpretation, and even more possibilities for misinterpretation" is a prototypical example of this stance. What he formulates for archaeology as a whole offers an even more serious threat to students of the Palaeolithic. Especially in the latter's branch of lithic research, efforts tend to be pooled in order to secure and solidify knowledge rather than to seek out new interpretive options. Although it is only natural that most lithic approaches attempt to narrow down the space of credible interpretations, there is also the risk of too easily discarding, bypassing, or even ignoring alternative readings of the disposable evidence:

> "Any archaeologist of good faith will recognise that the interpretation of the remains he offers is one of many other plausible ones; that it would be necessary to provide an inventory of all possible scenarios […] To take this plurality into account from the start indeed poses a cognitive challenge: the mind is not prepared to deal with such disparate, sometimes contradictory information. To say it in a few words, this plurality is partly due to the fragmentary nature of the considered objects: the world of remains is a totality amputated by various factors and laws, those of chance being not negligible." (Boissinot 2011: 267; my translation [the original French quote is given in **Appendix Q.3**])

As Boissinot (*ibid.*: 266) rightly points out, archaeological material, despite its tangibility and seemingly 'objectifying' qualities, is "much more problematic than one admits." Not only is there a real tendency to 'reify' the findings of the past (*ibid.*: 255), it is practically very difficult to make sure that one covers all of the relevant interpretive alternatives. In philosophy of science, this difficulty is known as the 'problem of unconceived alternatives' (**Box 1**);[8] it calls into question whether a convergence of evidence and interpretation is enough to mitigate the problem of knowledge. Even if researchers can assure that their knowledge claims are reasonably well-supported, there is still the possibility that some unconceived alternatives are equally substantiated by the evidence. How, then, can one ensure that all of the relevant alternatives are taken into consideration? The answer is that one cannot. The only solution is to bring the issue to the forefront of inquiry, and to impel scholars to not only work on the problem of corroboration but to actively explore the 'space of interpretation' as well.

We may argue that the 'problem of unconceived alternatives' is significantly aggravated in Palaeolithic research, not only because the latter's evidential foundations are extremely thin and knowledge claims consequently less constrained by the data at hand but also, and perhaps more importantly, because scholars are confronted with actors (and maybe even processes) that lack present-day correlates or even close analogies.[9] The prime examples are the various now extinct hominin species, the *Australopithecines* and *Homos* who have created the bigger part of the artefactual record available for the Palaeolithic. Another example are the members of the now similarly 'fossil' community of Pleistocene megafauna once populating the ancestral environments of the different stone tool producers. Again, how can one assure not to have missed an alternative yet crucial explanation in face of such basic uncertainty? The dangers of not even considering, let alone too quickly dismissing, potentially relevant propositions are arguably elevated in this context of inquiry.

Clearly, these considerations bring us back to the enduring and certainly influential picture of archaeology as an 'imaginative enterprise,' perhaps most lucidly articulated by Alain Schnapp (1993:

[8] Cf. esp. Stanford (2001, 2008, 2015).
[9] Cf. Collins (1999: 90) for a similar insistence on the possibility that "archaeological finds may have been deposited by activities which have no modern correlates."

30).[10] According to this widely held view, archaeologists cannot renounce from the exercise of 'imaginative reconstruction' since their evidence only weakly constraints their interpretations. Even if this situation offers an adequate description of what archaeologists usually do when they try to make sense of their evidence, it is not necessarily bound to promote uncontrolled, overly speculative thought or even nurture 'anything-goes' attitudes but simply compels archaeological scholarship to recognise that 'imaginative reconstruction' may be framed in different ways. The gap between archaeological data and archaeological interpretation solicited by the metaphor of 'imagination' clarifies that focussed archaeological 'puzzle-solving' (*sensu* Kuhn 1996 [1962]: 35-42) may require the development of powerful yet necessarily 'normative' guidelines of research, dictating *how* 'imaginative reconstruction' *ought* to be practiced.[11] Again, we should expect that these guidelines resonate with the sparse material evidence of the Palaeolithic in a much more ambiguous way than, say, with the comparatively rich Bronze Age record of Northwestern Europe.

All of these aspects undoubtedly complicate the quest for lithic knowledge of the Palaeolithic past. The nature of the available lithic evidence only weakly determines the mode of inquiry and makes it necessary to adhere to some kind of orientating principles to define and work on research problems in a constructive way. Since the nature of the lithic record prompts radical epistemological questions and because scholars simply cannot pause all the time to examine and reflect on these issues, standards of research become easily paradigmatic and sometimes even a matter of 'faith.' Even though it is completely understandable that practitioners wish to advance knowledge rather than to constantly question its foundations – an attitude which indeed appears to be somewhat 'masochistic' (Boissinot 2011: 301) – the threats of 'ideologisation' are definitely real. The apparent deficit of evidence and the lack of "natural" frames of reference promote 'strong' opinions on how lithic data should be handled. The temptation to fall back into a dogmatic stance is tremendously high (**Box 2**).

1.1.3 *The underdetermination of knowledge claims*

The foregoing discussion indicates that lithic research in Palaeolithic archaeology is plagued by issues of underdetermination. Forcefully introduced by Willard O. Quine (1951, 1960) in the middle of last century, the 'problem of underdetermination' draws attention to the fact that substantial statements about the world may be systematically underdetermined by the disposable evidence (**Box 3**). If this contention, which in its elementary variant has become widely known as the 'Duhem-Quine thesis,' is accepted, one has to acknowledge the general possibility that evidence may be not enough to discriminate between two or more competing knowledge claims; these knowledge claims may turn out to be 'empirically equivalent,' that is, may have the same factual implications (e.g. Kukla 1996: 137). The highly specific conditions of knowledge-formation outlined in the preceding sub-sections naturally render Palaeolithic archaeology a vulnerable target of various forms of knowledge-underdetermination. As a consequence, its practitioners are strongly predisposed to author a number of incompatible yet underconstrained assertions about the distant past and its protagonists.

While there is basic disagreement about the scope of underdetermination in science (cf. Turnbull 2017),[12] it is generally agreed that underdetermination plays a crucial role in sparking theoretical controversies and fuelling local interpretive conflicts, especially in the practice of the 'historical sciences of the deep past' (e.g., Turner 2005, 2007):[13]

---

[10] Cf. Thomas (1996: 63); Gamble (2001: 1f.) devotes the very first section of his introduction to archaeology to the issue of 'archaeological imagination.'

[11] Jones (2015: 324) takes up this point, arguing that the influential debates between proponents of 'objective-explanatory' and 'hermeneutic-interpretive' archaeologies waging between the 1960s and 1980s in the English-speaking world, especially in Britain, must be regarded as a prime example of the lasting struggle to frame 'imaginative reconstruction' in maximally productive ways. The 'scientific' (Binford, Clarke) and the 'hermeneutic' stance (Hodder, Shanks, Tilley, Thomas) must thereby surely be place into a broader perspective, complemented for example by 'structuralist-semiotic' modes of framing 'imaginative reconstruction' (Leroi-Gourhan, Brézillon) thriving outside of the Anglophone world.

[12] Turnbull (2017), in a short but informative review of the issue, distinguishes between four variants of underdermination (cf. **Box 3**). These variants presumably play varying roles in scientific research and are differentially controversial as to their reality, scope, and effects.

[13] See also Tucker (1998, 2004) and Forber and Griffith (2011); for a discussion of 'information destroying processes,' see Sober (1988: 3).

> "Because historical science is often marked by degrading signals, and thus incomplete data, it provides excellent source material for enquiring after the nature of underdetermination and how scientists respond to it. For instance, the fossil record is commonly understood as 'gappy': it in no way represents a trustworthy or unbiased sample of the history of life. This is because the conditions required for fossilization are highly specific, and the survival of subsequent fossils (not to mention their eventual discovery by palaeontologists [or archaeologists]!) is highly fragile. Under such conditions, underdetermination is a major concern." (Currie and Turner 2016: 43f.)

In light of the arguments presented so far, I suggest that the problem of lithic knowledge has at least partly to be re-defined in terms of the underdetermination thesis. The key issue, as it seems, is not that lithic scholars are poorly equipped to interpret their findings but rather that the available evidence is of such a nature that in the current state of investigation it, by itself, cannot satisfactorily direct them to the one most adequate knowledge claim. This proposition does not imply that researchers will never be able to effectively decide between competing interpretations of the lithic evidence; it merely contends that in the present state of affairs – given the theoretical and evidential resources *currently* available – students of lithic technology may be considerably compromised in their ability to make conclusive interpretive choices. We will develop this point in the next section.

At any rate, underdetermination is not just a 'philosopher's problem' (Kitcher 2001: 36) but affects the heart of the scientific conduct. Not only is it presumably much more widespread than typically recognised, especially in branches of research where the supply of evidence is extremely limited, underdetermination is also perceptible by scientists themselves (even though they may not immediately identify it as such) and greatly matters in how arguments are drafted and enquiries develop. The recognition of coexisting but possibly underdetermined knowledge claims may therefore help to recover some of the most persistent difficulties and interpretive conflicts that scholars face in their own arena of scientific practice, with Palaeolithic archaeology being no exception. Not unimportantly, acknowledging underdetermination as a serious problem re-directs the attention from purely philosophical issues of knowledge to the 'concrete' knowledge-generating practices of scholars and particular scientific communities.

1.1.4 ***The social tenacity of viewpoints***

It has long been recognised that scientific research is fundamentally shaped by social conditions; scientists, just like other members of society, work and live in social worlds. They have to navigate these social realities and often draw their inspirations and motivations from their lifeworld experience. Moreover, scientific investigation itself comprises a crucial *social* dimension. Research is traditionally organised in social compartments such as 'communities' or smaller 'peer groups' and the lessons learned and the pieces of knowledge gathered have to be horizontally distributed within these units as well as transmitted to a new generation of scholars (e.g., Longino 1990; Kitcher 1993, 2001; Bird 2010).[14] Since science is inescapably practiced in social settings and depends on social processes and structures to be successful, the analysis of scientific knowledge should be complemented by the examination of the sociological conditions of knowledge production – by what Karl Mannheim (1936 [1929]) and others have coined the 'sociology of knowledge.' Archaeological and lithic knowledge, respectively, are no exceptions in this regard and should be expected to resonate with the social milieus in which they are advanced.

The significance of the social context of research lies in its ability to act as a confined supply of resources; it for example helps to consolidate particular research interests, filters research questions, and anchors discussion points. It also guarantees the relative stability of processes of inquiry and provides the *place* to work on problems collectively. It is because of this social potency of research processes that practitioners can be said 'to stand on the shoulders of giants.' Through social structures and mechanisms, accomplishments and failures of research can easily be internalised so that they may instruct future investigations; in this way, practitioners are able to *build explicitly* on the efforts of their peers and the preceding generations of scholars. The social context of research hence also impli-

[14] I can only recommend the excellent treatment of this topic by Welbourne (1981).

cates the historical dimensions of knowledge production and transfer in a given field of inquiry or a community of scholars.

All of this matters for the present examination because the social substrate of research must be recognised as an important *reinforcer* of knowledge conflicts. Scholars working in different communities or peer groups may rely on different resources to refurbish, discuss, and/or perpetuate knowledge and thus ultimately come up with different ways of tackling similar problems. When knowledge claims are generally threatened to be underdetermined by the available evidence (see *supra*), differences in the social organisation of research may therefore easily incite or solidify disagreement, controversy, and antagonism. Again, the effect is likely to be strongest where the supply of evidence is relatively scarce.

The basic dependence of knowledge on the social format of inquiry has for instance lucidly been expounded by Ludwik Fleck (1979 [1935], 1936); the work of this author, often overlooked or underrated, provides a profitable point of departure to develop a firmer grasp on some key aspects of socially embedded processes of knowledge formation. According to Fleck (*ibid.*: 38, 40), scientific cognition is best understood as a three-party relationship, the meeting point of 'knowing subjects' (individual researchers), 'collectives of thoughts' (effective groups of researchers), and the 'objects to be known' (object-matters). The type of cognition that signifies scientific research is thus imbued with 'social activity' (*ibid.*: 38, 42f.). Two concepts are central in Fleck's reconstruction of the sociology of knowledge – 'collectives of thought' [*Denkkollektive*] and 'styles of thought' [*Denkstile*] (*ibid.*: 125, 1e42). The two are coextensive (*ibid.*: 41). The former represent the totality of scholars that commonly engage in collective tasks of inquiry while the latter reflect the distinct ways of doing science and talking about research and its objects which designates these groups and sets them apart from other groups.[15] The stylised form of cognition that, over the course of history, develops in a given collective of thought is never fully transparent, let alone consciously accessible to all or even most of its members (*idem*). 'Styles of thought' tend to rely on systems of expert terminology, often highly abstract and jargon-infused, as well as on fitting rhetorical strategies, typically opaque or "disturbing" to those who are not part of the issuing thought collective [*Stilfärbung*, *Stilzauber*] – each 'collective of thought' encourages specific 'habits of thought' (*ibid.*: 37, 42):

> "If we define "thought collective" as a community of persons mutually exchanging ideas or maintaining intellectual interaction, we will find by implication that it also provides the special "carrier" for the historical development of any field of thought, as well as for the given stock of knowledge and level of culture. This we have designated thought style. The thought collective thus supplies the missing component. [...] Cognition therefore means, primarily, to ascertain those results which must follow, given certain preconditions. The preconditions correspond to active linkages and constitute that portion of cognition belonging to the collective. The constrained results correspond to passive linkages and constitute that which is experienced as objective reality. The act of ascertaining is the contribution of the individual." (Fleck 1979 [1935]: 39f.)

Thought collectives work primarily with the resources they have internalised and are differentially susceptible to external developments. They form relatively enclosed systems of scientific opinion in which evidence is handled and interpreted according to the rules and norms defined by the accepted style(s) of reasoning. The implication is that these collective units of inquiry tend to cultivate particular perspectives and research orientations – a circumstance that Fleck (1979 [1935]: 30, 38) identifies as the 'tenacity' of collective viewpoints and stances of research. Collectives of thought turn out to be relatively 'stubborn' in how they normally muster data and render them significant. This is what is often referred to as the inherent 'conservatism' or 'orthodoxy' of larger units of research:

[15] For a discussion of the status and nature of 'collective scientific knowledge,' see also Fagan (2012). This review of the concept not only confirms that collectives are indeed required to produce credible scientific knowledge, it also highlights that the internal dynamics of social groups can really be decisive for the development of particular methodological norms of knowledge production.

> "Within science, a discipline acts both through and upon its adherents (see Prior, 1994), organizing knowledge-producing resources in response to institutional pressures and intellectual exigencies (Good, 2000) while at the same time establishing the object of inquiry for its members ontologically (Shepherd, 1993). Sullivan (1996) notes a further tension, in that scientists are expected to respect the traditions of their field but at the same time required to make novel contributions to it (224). He describes disciplinarity as operating via orthodoxies — hierarchical systems of canonical narratives, doctrines, methods, and commonplaces that represent the shared vision of a field (226-229). In their work, scholars legitimate themselves in the context of a discipline by "projecting an orthodox, yet progressive, ethos" (233), signaling knowledge and acceptance of most of a field's paradigmatic touchstones while challenging a few in order to say something relevant and worthwhile. In this way, disciplines are able to engage in knowledge production despite a deeply conservative impulse that, in seeking to sustain an existing community and maintain its intellectual rigor, serves as a barrier to the new (Wilder, 2005)." (White 2014: 1)

A key point is not only that thought collectives necessarily introduce 'elements of wishful thinking' (Fleck 1979 [1935]: 32) and tend to foster 'self-fulfilling expectations' (*ibid.*: 33), they crucially predefine the space of the 'thinkable.' The resources available to a collective unit of inquiry, including all of its past discursive successes and failures, will – to a large extent at least – *regulate* what can count as a reasonable alternative and what is generally 'imaginable' as an interpretive option (*ibid.*: 28). Credible alternatives to the dominant viewpoints have to be developed internally and need to withstand the critical scrutiny of collective standards. This condition, together with the general tenacity of knowledge production on the level of research communities, certainly amplifies the 'problem of underdetermination.' When the evidence is limited and research communities built on a different fabric collide, we may have to deal with the reality of two or more opposing clusters of perfectly alternative readings of the same object-matter, suggesting that the space of interpretation itself is fundamentally mutable.

For a long time already, archaeologists recognise that their social matrix of research is extremely heterogeneous (cf. e.g., Dennell 1990; Clark 1991a; Scarre 1999). Different 'disciplinary traditions' or 'national research legacies' often start with very different assumptions about the past and provide researchers with incompatible interpretive intuitions (e.g., Otte and Keeley 1990; Knüsel 1992; Straus 2001a; Johnson 2010: 231-233).[16] Murray (2013: 22), for example, has recently concluded that "the 'culture' of archaeology, i.e. background knowledge, experience, and the givens of its practice, can no longer be considered to be widely shared among practitioners." The thrust of discussions waging at least since the 1960s, however, had a lasting impact primarily on what we may call Holocene archaeologies, leaving Plio-Pleistocene archaeology including its Palaeolithic branch largely unaffected.[17] This is rather ironic since the latter, as we have seen, offers unique challenges to practitioners and their quest for trustworthy knowledge of the most distant past.

1.2 **The French-Anglophone divide**

After having established the characteristics of lithic knowledge formation and some of its difficulties in Palaeolithic archaeology, we can now turn the attention to the French-Anglophone divide itself. This section pursues two interrelated goals. I will commence with a general exposition of the separation between French and Anglophone research endeavours and the crisis of lithic knowledge it embodies, before calling upon three paired case studies to illustrate that the divide is substantial enough to author strictly incompatible knowledge claims. It has to be said that the French-Anglophone divide is not a struggle of individual women and men, though, but rather stands for, as will be laid out, a clash of two evolved social structures of research rooted, among other things, in divergent disciplinary histories. Although the contemporary divide is the primary object-matter of the present investigation, its purpose is exemplary. I do not wish to suggest that the ongoing quarrel between French and Anglo-

[16] See also Shanks (1992: 16), Murray (1993), Coye and Hurel (2013), and Delley et al. (2017).

[17] This is not to say that there has been a lack of research on the historical and epistemological foundations of Palaeolithic archaeology, to the contrary (cf. e.g., Clark and Willermet 1997; Corbey and Roebroeks 2001; O'Connor 2007; Lippé 2007, 2012; Sommer 2007; Goodrum 2009, 2014; Bon 2009; de Beaune 2010, 2016; McNabb 2012a; Guillomet-Malmassari 2012; Van Reybrouck 2012; Bednarik 2013). The point is rather that existing work has only rarely addressed questions of cognitive diversity and has typically focussed on spelling out the characteristics of a well-defined unit of inquiry, often simply taking specific epistemic values and/or conceptual tenets for granted.

phone research traditions constitutes *the* key obstacle in modern lithic studies, let alone the only one; I do believe, however, that learning from this prominent case – the two undoubtedly represent the perhaps most influential poles of Palaeolithic research in the Western tradition – will help to extract more general lessons about the conditions of lithic knowledge production in Palaeolithic archaeology.

1.2.1 *The parting of the ways*

In her recent review of French-U.S. relations in Palaeolithic archaeology, Perlès (2016: 231) emphatically concludes:

> "I believe that apart from certain semantic convergences the divorce between French and Anglo-Saxon approaches is profound and that the divergences are, in reality, still profound today and in fact exist since the early days of studying lithic technology on both sides of the Atlantic." (my translation [for the original French quote, see **Appendix Q.4**])

This statement stands for the latest episode of a long-felt dissatisfaction with the persistent segregation of French and Anglophone research endeavours (cf. Clark and Lindly 1991; Wargo 2009). Although practitioners tend to disagree about the gravity, scope, and relevance of the divergence between French and Anglophone lithic approaches, there is a common sense of 'unease' shared by most, if not all, researchers concerned with understanding the lithic record of the Palaeolithic. While some believe the divide is really 'absolute' and 'paradigmatic' (e.g., Straus 1987, 1991, 2002b; Clark 1993, 2002; Monnier and Missal 2014) others have hardly become tired of highlighting that there is also much topical overlap and conceptual congruence to be found at the French-Anglophone interface (e.g., Audouze 1987; Bleed 2001; Monigal 2002: 125-127; Chazan 2014). Middle-ground stances appear to be surprisingly rare (cf. de la Torre and Mora 2009).[18] Despite this difference in opinion and emphasis, the French-Anglophone divide is rarely questioned entirely and scholars usually accept it as a reality of practice rather than casting it as a disputed fact (cf. Tostevin 2011b, 2012: Chapter 3; McCall 2015: 69).

The lack of consensus in terms of the stakes and the cognitive significance of the French-Anglophone divide is arguably a result of ongoing troubles to clearly grasp its epistemological dimensions. Lithic experts have, first and foremost, endeavoured to account either for the methodological repertoire or the theoretical landscape supposedly diagnostic of the two research formations (esp. Chazan 1997; Bleed 2001; Shea 2003; Tostevin 2011a; de la Torra and Mora 2009; Perlès 2016), but hitherto merely scratched the surface of their anchoring conceptual spaces. To the knowledge of the author, naturally limited as it is, there exists to date not even a single in-depth study exploring the epistemological foundations of French-Anglophone relations in palaeolithic archaeology. Needless to say, such an exposition is desperately needed to break the 'spell of style' [*Stilzauber*] (*sensu* Fleck 1935) that tends to cloud the vision for the collective research endeavours one does not participate in, simply stipulated as the 'other' (see previous section).

What we typically encounter at the French-Anglophone interface is a marked imbalance of accounting for oneself and this cognitive 'other.' Most of the time, scholars appear to be rather familiar with their own research background(s), but have obvious difficulties to adequately depict or come to terms with the other side. The symptoms of this situation are manifold and diverse but we clearly encounter signs of 'ideologised' trench warfare, heated and emotionally charged accusations, plenty of mischaracterisation and 'talking past each other,' and even open defiance and hostility. At the same time, however, the divide, especially in the last couple of years, has increasingly been cloaked with silence and muteness. This paradox may be evidence to suggest that the relationship between French and Anglophone lithic practice has become an extremely sensitive topic and, even though being deeply troublesome, has reached some sort of historical deadlock.

The following subsections will address some of these aspects in more detail, providing a problem-oriented review of the available literature. This will not only bring the French-Anglophone division into clearer focus but also allows us to provide a first assessment of the more practical problems it creates. The exposition will show that a strong sense of 'antagonism' pervades the field and that scholars seem to struggle tremendously with basic communicative issues – a configuration that, overall, suggests that we are indeed confronted with two relatively self-contained research communities. The

[18] But see perhaps Shott (2003, 2007) and McCall (2015: 69).

aftermath of the ‘Binford-Bordes debate’ offers a valuable entry point into the discussion, situating the French-Anglophone divide on the historical plane.

1.2.1.1 *The aftermath of the Binford-Bordes debate*

The ‘Binford-Bordes debate’ is often considered a textbook example for the interpretive conflicts created by the lasting struggle of grasping the significance of lithic evidence and coming to terms with it (Binford and Binford 1966; Binford 1972, 1973; Bordes 1968, 1972; Bordes and Sonneville-Bordes 1972; Rigaud 1978; cf. Wargo 2009); it is thought to showcase some of the ‘perennial’ problems of interpretation that researchers face when they embark on the quest for lithic knowledge (e.g., Monnier and Missal 2014). Yet the debate, centred on the issue of explaining the nature of interassemblage variability in the French Mousterian, also tends to be framed as a winner’s story, as a testimony of the ‘rationalist’ impetus of science to progress and solve its problems. Ignoring for a moment that the controversy remains far from being resolved, since none of the originally taken positions turned out to be defendable, this portrayal of the debate blurs the vision for its long-term effects on French-Anglophone interactions. Although the dispute between Binford and Bordes, launched and cultivated by the former, was surely influential and marks the heyday of direct confrontation between members of the two research traditions, it ironically resulted only in further and this time much deeper-running alienation. It is this latter impact of the ‘Binford-Bordes debate’ that merits particular attention in the present problem context.

An important document of the aftermath dynamics of the debate is Binford and Sabloff’s *Paradigms, Systematics and Archaeology* (1982). In this polemic piece of scholarship, the authors argue that the archaeological research landscape has become fractured into two larger spheres of inquiry: a ‘New World tradition’ and an ‘Old World tradition.’ According to Binford and Sabloff, these two traditions of continental-scale are based on two mutually exclusive conceptions of culture which, over the course of disciplinary history, have given shape to fundamentally distinct methodological and theoretical repertoires, echoed in different ‘observational languages’ (cf. Clark 1991b: 85). Without going into the highly problematic details, this perceived duality between ‘New World’ and ‘Old World’ was certainly foreshadowed by the foundational agenda of the *New Archaeology* and its insistence on the sharp division between ‘historical’ and ‘processual’ archaeologies (e.g., Sabloff and Wiley 1967; Binford 1968a, 1972, 1982; Meltzer 1979). For early-day ‘processualists,’ the ‘Binford-Bordes debate’ assumed a legitimatory role and served as a focal point of reference to frame research problems more generally. All of this created the impression of an unbridgeable gulf between Continental European research on the one hand and U.S. American scholarship on the other – a vision that would later develop a life of its own through the work of the so called ‘Chicago cohort’[19] (cf. Clark 1987, 1991b, 1993, 2002, 2006, 2009; Clark and Lindly 1991; Clark and Willermet 1997; Straus 1987, 1991, 2002b, 2005; see *infra*).

The picture sketched by Binford and Sabloff was for the most part already anachronistic when it was published. Although Audouze and Leroi-Gourhan (1981) encumbered the strange ‘continental insularity’ of French research not later than a year before *Paradigms* was published, the latter still puts forth the conception that European archaeology can be addressed as a fairly homogenous entity, resting only on a small number of basic tenets. The totality of European research was pigeonholed as decisively ‘non-anthropological,’ resting almost exclusively on the sockets of ‘culture history.’ In hindsight, the fatal pitfall was perhaps to regard François Bordes as the generic prototype of French, and by extension European, scholarship in the field. Bordes became indeed more and more canonised as the embodiment of French-type Palaeolithic archaeology, not only because of the writings of Binford and his followers, but also because he himself (Bordes 1968: 7) at least encouraged this flattering idea (cf. Sackett 2014).

All of this must be read against the background of a new emerging player in the French research landscape – Leroi-Gourhan and his Parisian school. By the early 1980s, Paris had become the emerging centre of Palaeolithic research, at least complementing Bordeaux and increasingly setting a new agenda of inquiry; this agenda would drive the French tradition slowly but surely away from its

[19] The term ‘Chicago cohort’ refers to a group of young scholars that during the 1960s, on the peak of the *New Archaeology* movement in the United States, became heavily influenced by the Binfords in Chicago (cf. Trigger 2007: 393; Wargo 2009: 106; Straus 2017).

Bordian stakes. The main point is that the research mandate issued by Leroi-Gourhan (Sorbonne) and later Jacques Tixier (Nanterre) placed Palaeolithic research on a novel cognitive basis (e.g., Leroi-Gourhan 1971, 1982, 1983a; Leroi-Gourhan et al. 1976; Tixier 1978 [2012]; Tixier et al. 1980; Pelegrin et al. 1988; Inizan et al. 1995 [1999]), signifying a proper turning point in French disciplinary history (cf. Perlès 1987, 1991a; Schlanger 1990, 2005; Karlin 1991; Geneste 1991 [2010]; Valentin 2011: 92-94, 110-118). The fruits of this creeping revolution, already underway when *Paradigms* was drafted, would lay the foundations of what is known today as *« Palethnologie »* (*Ethnologie préhistoire*) and the 'technological approach' (*Technologie préhistoire*) respectively (e.g., Valentin 2011: 93; Coye 2015; Audouze et al. 2017) – together forming the 'double genealogy' of the modern French tradition (s*ensu* Ramírez Galicia 2016).

The continued preoccupation with Bordes, the central reference point of an entire research trajectory incited by Sally and Lewis Binford in the late 1960s,[20] ensured that these critical developments were largely overlooked or marginalised on the other side of the Atlantic. This promoted the certainly false impression that French mainstream-research was yet of a 'Bordian' character. The idea, *grosso modo*, still permeated Anglophone receptions of the French tradition in the 1990s, for example echoed in Sackett's (1991) defence of French 'straight archaeology' in the Bordian spirit. Dennell (1990: 555f.), in a short but informative paper on the politics of Palaeolithic archaeology, even proposes that the 1960s herald the 'American takeover' of Old World research and the decline of Continental European centres of inquiry such as Paris. In accordance with Villa (1991) and many others, he (1999: 802-804) articulated the now popular viewpoint that the rise of the various 'New' archaeologies in Britain and the United States at the time (e.g., Binford and Binford 1968; Clarke 1968; Binford 1972) caused a sharp recession in the wider significance of the French tradition, ushering in a new age of 'American supremacy' in the field (cf. Dennell 1983):

> "The 1960s also marked the eclipse of the French domination of palaeolithic studies by American ideas [...]. As part and parcel of the New Archaeology, palaeolithic archaeologists shifted their focus from the development of cultures and their components through time to the behaviour of individual groups, and the interrelationships of their technology, social organization and environment. This in turn fostered a more closely integrated, interdisciplinary approach. In British circles, this approach grew out of the Cambridge palaeoeconomic approach developed by Grahame Clark in the 1950s (Clark 1952), and Eric Higgs in the 1970s (Higgs 1975). American developments were always more rooted in anthropology than in Europe, and owed much to the galvanizing influence of Lewis Binford in forcing attention away from descriptions of archaeological cultures to analyses of how their components interacted with each other and their environment (see, for example Binford 1983; Binford and Binford 1966)." (Dennell 1999: 804f.)

This portrayal of recent disciplinary history, in essence shared by many Anglophone scholars until today, overlooks that the approaches set in motion by Leroi-Gourhan, Brézillon, and Tixier in Paris between the 1960s and 1990s were equally significant and similarly based on an anthropological vision of the past, although of course framed in a different way – as an extension of French *« Ethnologie générale »*.[21]

In total, the Binfordian optic has tended to reduce the French tradition to its Bordian stakes and stipulated the emergence of 'processualism' in the Anglophone world as the only proper revolution of the 1960s. Meanwhile, however, French scholars witnessed their very own turnover and it was not driven by a 'processualistic' impetus at all (cf. Perlès 1991a; Coudart 1999; Audouze et al. 2017). The marginalisation of these key developments in the Anglophone heartland clearly undermined the possibilities for a serious *rapprochement* after the 'Binford-Bordes debate.'[22] The aftermath of the debate may have therefore eventually produced a much deeper rupture in the research landscape than the one it initially sought to address. The dynamics of the unleashed discourse indicate that the 'Binford-

---

[20] Cf. Binford and Binford (1966, 1968); Binford (1972, 1973).

[21] It is a telling example that Wargo (2009), in her 160 page dissertation on the 'Binford-Bordes debate,' even when setting up the intellectual backdrop of the debate mentions Leroi-Gourhan, let alone Tixier, only in the passing. She (*ibid*.: 97) explicitly notes: "Like La Place [*sic!*], Brézillon, and for that matter Leroi-Gourhan, never achieved the recognition and the level of authority and influence that Bordes had gained." Other passages suggests a more balanced but still ambivalent view of the Parisian legacy (esp. *ibid*.: 118).

[22] A notable exception is the work of Margaret Conkey and her students, who paid notable attention to the *œuvre* of Leroi-Gourhan (cf. Conkey 2014; Dobres 1995). However, with her research focus on gender studies, practice theory, and visual culture in the Pleistocene she was probably too much of a borderline figure to have a strong effect on the Anglophone mainstream, especially on scholarship which concerned itself primarily or exclusively with the study of ancient stone technology.

Bordes debate' acted as a potent catalyst of divergence, leaving behind two separate discursive spaces with little intention or incentive of interaction.

1.2.1.2 *Harbingers of an allusive rivalry*

From the 1990s onwards, the amount of literature explicitly or implicitly dealing with the difficulty of French-Anglophone relations in Palaeolithic archaeology has virtually exploded (e.g., Harrold 1991, 2002; Dibble and Debenath 1991; Sellet 1995; Chazan 1997; Tostevin 2000: 64f.). Yet, the overall picture did not change dramatically since the foundational controversies of the 1960s, and discussions were rarely more than alerting monologues. Like shortly after the 'Binford-Bordes debate,' there was surprisingly little reaction to the unsettling voices uttered primarily by Anglophone researchers. As Wargo (2009: 130) has pointed out, however, this might well have had something to do with the 'patronising tone too often taken by American archaeologists' when engaging with their French colleagues.

The excursions of Geoffrey Clark and Lawrence Straus, both extant members of the 'Chicago cohort,' into the epistemology of Palaeolithic research exemplify this general attitude (e.g., Clark 1987, 1991a, 1993, 2002, 2006, 2009; Clark and Lindly 1991; Clark and Willermet 1997; Straus 1987, 1991, 2002b, 2005). Although their intentions were certainly honourable, namely to spark a new discussion about the footing of Palaeolithic knowledge, their rhetoric tended to be 'colonial' and their conclusions were too often one-sided. Their approach was characterised by a high degree of confidence and as such an extension of the general take on the past propagated by the *New Archaeology* and its associates some decades earlier. Harrold (2002: 29) has rightly noted that this confident attitude may easily swap into 'hubris' and is even more easily interpreted as such. The point is that these authors never really managed to escape from their partisan viewpoints (e.g., Clark 2002) and it is perhaps less surprising that they consequently never received a satisfying reply from any revered French authority.

Clark and Straus identified a – in their opinion – disquieting and ever-growing rift between French and Anglophone, especially U.S. American, research into early human evolution, which they moulded upon some of the dualities established by Binford and Sabloff in the early 1980s. Over the years, they have repeatedly insisted on the need to systematically disclose, discuss, and ultimately 'seal' the most severe discrepancies threatening to tear apart the 'science of early man' (e.g., Straus 1987, 2002b; Clark 1993, 2001).[23] Yet their efforts faced a basic dilemma: while they wanted to call attention to inherent difficulties of conceptualising the deep past and devising effective cognitive resources to gain knowledge about it, their scholarship was born out of the adamant conviction that there can only be one admissible answer to every valid question; committed to the basic epistemology of the 'New' archaeologies, their vision of science and objectivity was non-negotiable (e.g., Clark 1994). As a result, diverging perspectives on the past could not equally be true – a realisation that drove them into the temptation of pinpointing and eliminating 'pathologies of reasoning' rather than identifying the enabling qualities of inquiry. Even though they also touched upon their own 'biases' (Clark 1991b), they ultimately argued that Anglophone approaches are less 'pathological' (cf. Clark 2002, 2009, Straus 2002b) – a view that has been slightly relaxed only recently (cf. Straus 2005).

Partly because they rarely took issue with any specifics of research but concerned themselves with generalities, their accounts are littered by 'stereotyping' and more or less obvious mischaracterisation (we will return to some of these aspects in Chapter 6). The important lesson is that we can only take issue with the French-Anglophone divide from a situated viewpoint, as Clark and Straus did, if we already *assume* that this perspective is somehow preferable. Such a strategy, however, clearly begs the question of whether an investigation of the divide can provide some valuable insights into scholarly practice, its possibilities and limits, on *both* sides. As long as no neutral ground is taken – at least temporarily – there will not emerge any fair and productive treatment of the problem. What remains are only polemic pieces of partisan critique. All of this clearly suggests that the particular way in which Clark and Straus have construed French-Anglophone relations has, in fact, only further *widened* the gap between the two research spheres. Even though they themselves have persistently cautioned

[23] The phrasing 'science of early man' is for instance explicitly used by J. Desmond Clark to refer to the multidisciplinary endeavour of *Paleoanthropology* (e.g., Clark 1986; see *infra*).

against the pitfalls of 'talking past one another' (Willermet and Clark 1995; Clark 2001: 39; Straus 2002a), they ironically seem to have contributed not insubstantially to similar practices.

Having said this, the picture of French scholarship presented by Clark, Straus, and others has surely influenced the general perception of French-Anglophone relations in American and British research circles, foreshadowing a growing dissatisfaction and frustration with the apparent ignorance of the French scene, which was seemingly unwilling to take a stance against any of the raised issues (e.g., Tostevin 2011b: 351f.). Beginning in the early-to-mid 1990s, some of the general concerns formulated by scholars like Clark and Straus were nonetheless taken up by a new generation of Anglophone researchers; the spotlight, however, irrevocably shifted from the more general predicaments of interaction to the specific discrepancies of interpreting the lithic evidence (cf. Van Peer 1992; Dibble 1995a; Odell 2001: 81; Shott 2003, 2007; Pettitt 2003: 38; Brantingham and Kuhn 2004; Sandgathe 2004; Steenhuyse 2008: 255; Tostevin 2011b, 2012: 164; Shea 2011a: 49, 2017a: 29; McCall 2015: 69). Perhaps partly as a latent reflex of the antecedent 'Binford-Bordes debate,' incompatible readings of the Middle Palaeolithic record in the two spheres of inquiry increasingly heated up the contention, while more and more critical voices were raised against the French 'technological approach' and its methodological foundation.

A focal point of the conflict was, and continues to be, the interpretation of Levallois technology. The French technological vision of Levallois, especially the specific understanding championed by Éric Boëda (1986, 1994) and his co-workers, was from its inception met with deep scepticism in the Anglophone world. Van Peer's authoritative *The Levallois Reduction Strategy* (1992), containing a devastating critique of the Boëdian notion of Levallois reduction,[24] illustrates this basic sentiment (cf. Scott 2011: 12-15). The need to discuss the varying perspectives on Levallois resulted in a major conference on the topic held in Philadelphia, where researchers from different geographic and intellectual backgrounds met to engage in a critical discussion about the definition and interpretation of the Levallois phenomenon (Dibble and Bar-Yosef 1993, 1995). A central point of friction has always been the notion of 'predetermination,' a key ingredient of the original definition of Levallois reduction by French technologists, which was increasingly viewed by many leading Anglophone experts to be inescapably coloured in subjective judgement. This subjective element is also highlighted in the initial report on the results of the Philadelphia conference:

> "Levallois has traditionally been defined as a method for predetermining flake shapes. Perhaps because of the subjectivity involved in assessing such predetermination, the recognition of Levallois products is quite variable, depending on the experience and perspectives of individual researchers. The many approaches that have been applied to this problem, including replicative experiments, refitting, and statistical analyses, have often produced conflicting results. Moreover, no criteria have been agreed on for defining industrial variants of Levallois technique." (Dibble and Bar-Yosef 1993: 77)

In the proceedings of the Philadelphia meeting, published two years later, Dibble (1995a) embarked on yet another attempt to ignite critical discussion – long overdue in his view – on the Levallois problem, launching an attack at Boëda's (1988) earlier interpretation of the lithic assemblage from Biache Saint Vaast level IIA on which the latter had based his definition of 'Levallois recurrent.' Again, criticism was primarily levelled against the supposedly 'non-objective' and 'non-replicable' nature of the presented technological reading of the lithic evidence (cf. Steenhuyse 2008: 255; Tostevin 2011b: 359, 2012: 95; Monnier and Missal 2014: 61). Chazan's (1997) lead review on Levallois technology in the *Journal of Human Evolution* concords with this basic recognition, adding that Boëda's account of Levallois crucially relies on 'flashes of intuition.'

The general opinion in the lithic specialist literature is that the French 'technological approach' tends to author overly 'speculative' and rather 'idiosyncratic' (that is, fairly 'incomparable') accounts of the available lithic data. This view is also echoed in Odell's (2001: 81) critique on the almost 'mystical ramifications' of the *chaîne opératoire* approach and its problematic 'immersivity.' Much of this criticism, however, reflects difficulties of coming to terms with explicitly 'qualitative' perspectives on the lithic material, advocated by Tixier and his students from the 1980s onwards (cf. Perlès 2016); the basic circumstance that many *chaîne opératoire* studies seem to lack a strong quantitative footing is simply taken to suggest that they fall short in 'analytical rigor:'

[24] Cf. esp. Van Peer (1992: 5-8, 64-90).

> "[…] Boëda's reliance upon a visual reading of the cores and débitage of the [Kulna] assemblage, without the corroboration of cumulative and recorded observations, did not enable him to recognize trends in the débitage that were easily revealed through attribute analysis. Other advocates of the *chaîne opératoire* approach to Paleolithic archaeology do not suffer from such a lack of analytical rigor, for instance Geneste (1985, 1988), Pelegrin (1990a, 1995), and scholars fortunate enough to possess extensive refittings […]" (Tostevin 2000: 67; original emphasis).

Levallois reduction has since been modelled in a number of alternative ways by Anglophone researchers (e.g., Baumler 1987; Sellet 1995; Kuhn and Brantingham 2004; Sandgathe 2004; Brantingham 2010; Scott 2011). Yet the general discontent with French practices of 'technological reading' boiled up again with the publication of Bar-Yosef and Van Peer's influential *The Chaîne Opératoire Approach in Middle Paleolithic Archaeology* (2009) in *Current Anthropology*. Their open critique questions the capability of *chaîne opératoire* approaches to reliably reconstruct technological realities. The authors lament primarily what they regard as manifestations of 'formal determination' and 'definitional imprecision,' in their view two highly problematic dimensions of the 'technological approach' impeding its cognitive credibility:

> "There can be no question that the *chaîne opératoire* concept has brought a fundamentally new perspective to the analysis of Middle Paleolithic assemblages, and it is certainly not our intention to diminish the contribution of technological studies to achieve valid interpretations of human behavior in the past. We have only wanted to draw attention to a number of epistemological problems in an effort to reinforce the ties between the analytic means and the explanatory ends of archaeological inquiry and to reduce the danger of becoming trapped in unproductive formal determinism. Nor has it been our intention to question the epistemological necessity of technological classification. It is instrumental to reveal patterning in the record and, hence, to provide us with an empirical basis for reflection on population-level processes. In some of its present forms, however, we perceive a degree of overformalization and an inability to be objectively applicable by different researchers due to lack of explicitly described criteria. In a way similar to the redundant typological paradigm that was employed in the past, the technical methods now seem to exist in isolation." (Bar-Yosef and Van Peer 2009: 117; original emphasis).

As Tostevin (2011b: 351f., 2012) has noted, it is certainly surprising that this apparent clash of proponents of the 'reduction sequence' approach and advocates of the *chaîne opératoire* (cf. Shott 2003; Dibble 1995a) continues to attract so little attention by the latter; not even a single high-profile lithic expert from a key research institution in France has reacted openly in the commentary section to Bar-Yosef and Van Peer's treatise, even though some, according to Tostevin (2011b: 351f.), were apparently involved in the review process. Conversely, the paper's reception by Anglophone commentators was overwhelmingly positive, providing the opportunity for a number of leading figures to update or renew their viewpoints. The general point of view articulated in the commentary section is that the critique was long overdue. Notable are the remarks by Monnier (2009) and Conard (2009). The former takes Bar-Yosef and Van Peer's discussion as further indication that *chaîne opératoire* approaches tend to conflate description and interpretation while the latter concludes that the 'technological approach' – qua *paleopsychology* – has hitherto indeed been little productive in revealing significant patterns of past behaviour and remains compromised by its inability to connect with general social or evolutionary theory. Conard's (2009: 188f.) argumentation not only reiterates a Binfordian trope from the 1960s,[25] it also takes up the widespread Anglophone viewpoint – canonised by Binford, Sabloff,

[25] Binford himself (1972: 198) maintained that 'palaeopsychology is a dangerous business' and sought to remove all of its seeds in order to place archaeology on a firmer 'scientific' footing (cf. Trigger 2007: 401). In a highly interesting interview, Sally Binford (in Clinger 2005: 196) has reiterated this criticism in the context of the 'Binford-Bordes debate,' showing how deeply engrained this perception still is: "[…] You can make up a lot of stories about what inter-site variability means, but unless you have formulated hypotheses which can be tested, it's just science fiction. Functional hypotheses, that is differences in what people were doing and how they were extracting energy from their environment, can be tested against independent data, but interpretation about their ideology or their spiritual life or their ethnic loyalties – we don't find this stuff in sites. That's all sci-fi. *Paleopsychology is a dangerous field* […]" (emphasis added). This reference to 'science fiction' is also echoed in a more recent enunciation by Shea (2017a: 192): "Just as there is neither a quintessential French way to make a baguette nor an essentially American way to drive a car, different ways of making stone tools are strategies deployed by individuals under variable circumstances. Applying a strategic perspective to the stone tool evidence is simply applied uniformitarianism, the common theoretical touchstone for all natural history (Tooby and DeVore 1987). By requiring us to base our explanations on evidence for past hominin behavior on observations of strategic variation in human and non-human primate behavior today, uniformitarianism is a quiet voice reminding us of the difference between science and science fiction."

Clark, and Straus – that French technological research operates in a 'theoretical vacuum,' largely uninformed by any relevant body of higher or middle-range theory.[26]

Although Tostevin (2011b), in a more recent paper on the relationship between 'reduction sequence' and *chaîne opératoire*, provides a more nuanced perspective on the issue of 'theory' in French lithic inquiry, he also contends that the 'technological approach' remains informed by the highest and most abstract level of theory and clearly lacks a bridging 'middle-range' component. Following Shott (2003), he adds that the writings of Mauss and Leroi-Gourhan, acting as key sources of theoretical inspiration, are indeed 'outdated' and therefore "not without their problems" as a baseline for lithic research (Tostevin 2011b: 334). Even if we accept this qualification for a moment for the sake of argument,[27] it is clearly suspicious that the role and nature of theoretisation supposedly characteristic for the French tradition are determined by reference to distinctly Anglophone concepts (Tostevin 2011a). The now routinely employed distinction between 'low,' 'middle,' and 'high-level' theory has its origins in the 'processualist' movement of the 1960s to late 1980s (e.g., Binford 1977, 1978; Schiffer 1988) and is tied to a rigorous separation of the 'observational' and 'theoretical' dimensions of knowledge-production (cf. Thomas 1998), implying a particular understanding of 'theory' and 'data' not necessarily shared by other research trajectories.[28]

The issue of theory has indeed become a lodestone of conceptual friction and illustrates quite plainly how far French and Anglophone research spheres have drifted apart. While Binford (1962) and others proclaimed in the 1960s that archaeology is 'anthropology or it is nothing,' the prehistory of human origins – to paraphrase Glyn Isaac's (1989) take on the discipline – has increasingly been placed into a Neo-Darwinian framework, casting Plio-Pleistocene archaeology as an extension of 'Human Evolutionary Studies' in the distant past (cf. Sommer 2007; Goodrum 2009).[29] Already Binford, Butzer, Clarke and other founding figures of modern Anglophone Palaeolithic archaeology put 'ecological theory' centre stage, re-casting anthropology essentially as 'ecological anthropology.'[30] Yet, the big game changer, especially in the United States, was the formation of *Paleoanthropology* in the wake of Howell, J. Desmond Clark, and Isaac in Berkeley (Clark and Howell 1966; Butzer and Clark 2007; Klein 2013), redirecting the study of early hominins towards biological anthropology, primatology, and the life sciences more generally. Glynn Isaac's legacy (1980, 1989) would later give way to a type of human origins research grounded in ecologically-oriented landscape archaeology (e.g., Potts 1988; Blumenshine et al. 2012),[31] the investigation of primate behaviour (e.g., Toth and Schick 2009a), and, more recently, cognitive neuroscience (e.g., Stout 2011; Stout and Hecht 2017).

In the United Kingdom, modern Palaeolithic archaeology tends to be an amalgamation of Clarke's 'Analytic Archaeology' (1968, 1972a, 1977),[32] the 'Cognitive Archaeology' school and its evolutionary psychology inheritance (e.g., Mellars and Gibson 1996; Mithen 1996; Gowlett et al. 2012),[33] and Higgs-style 'palaeoeconomics' (e.g., Higgs 1972, 1975; Bailey 1999) – a somewhat radicalised offshoot of 'Economic Anthropology' in the wake of Grahame Clark,[34] Dennell, Mellars, and Barker. British Palaeolithic archaeology, much stronger than its North American counterpart, is rooted in 'Geoarchaeology' and the Quaternary sciences (e.g., O'Connor 2007; McNabb 2012a), yet also owes a great debt to Clark and Isaac whose transfer to the United States initiated a lasting exchange between the

[26] See also Bar-Yosef and Van Peer (2009: 114).
[27] Mauss and Leroi-Gourhan are of course only the fundamental touchstones of much broader theoretical movements and their ideas are constantly refined and updated (cf. e.g., Warnier 1999, 2009; Sigaut 2012).
[28] See Chapter 3 for a detailed treatment of this issue.
[29] Straus et al. (2011: 322), for example, have retrospective characterised the Binfordian research mandate in the following way: "[a]rchaeology was to be a laboratory for pushing the scientific study of systems for human survival back into the past, both recent and remote, to enable the actual analysis of cultural evolution in particular cases that should respond to general laws in rational behavior. In fact, Binford and colleagues wanted American archaeology to do what it had long professed, namely *anthropology*, not collection, classification, and pseudo-ethnic systematization for its own sake." (original emphasis)
[30] Cf. Binford (1968b), Butzer (1971, 1986), and Butzer and Isaac (1975).
[31] It is often forgotten that the re-discovery of the 'landscape' in early human origins research was not only a consequence of the general reorientation of inquiry towards ecological questions. The 'spatial turn' of the late 1960s to 1980s was also powered by a symmetrical development between Clarke's 'Analytic Archaeology' (1968), understood as one incarnation of the various 'New' archaeologies of the time and later reinvented as 'Spatial Archaeology' (Clarke 1977), and the 'New Geography' movement in Cambridge between the 1950s and 1970s (Haggett 1965, 1972; Chorley and Haggett 1967; Everson and FitzGerald 1969; cf. Trigger 1998: 697). The rise of 'spatial' and 'geographic' archaeologies (e.g., Hodder and Orton 1976; Orton 2000) was ultimately an attempt to draw together conceptual resources from anthropology, ecology, and human geography – what Isaac (1980) would memorably capture with his ambition of 'casting the net wide.'
[32] Cf. Isaac (1977c) and Hammond et al. (1979).
[33] Cf. Abramiuk (2012: 10-20) and Gamble et al. (2014: 16-24).
[34] Cf. Trigger (2007: 358-361).

two English-speaking countries (cf. Reid 1980: 878; Straus 2007: 163). As a result, the spectrum of general theory deployed in the Anglophone world strives for consistency with, and is partly predefined by, this basic research topography (cf. Gowlett 2010).[35] In *American Archaeology's Uncertain Future*, Geoffrey Clark (2003: 52) bears testimony to this specific orientation of inquiry:

> "Paleoarchaeology [...] relies relatively little on concepts and models derived from social and cultural anthropology and much more heavily on those of biological anthropology, primatology, and cognitive neuroscience."

As Shea (2011a, 2011b, 2017) has repeatedly stressed, it has indeed become a pressing concern for many Anglophone scholars to contribute to the larger questionnaire emerging from the prism of Neo-Darwinian evolutionary theory, or at least to offer some insights which are digestible by the broader multidisciplinary endeavour of *Paleoanthropology* (Clark and Willermet 1997; Kuhn 1995, 2004a; Schick and Toth 2001; Klein 2009; Freeman 2009). In this context, Shea (2013b: 154) made it particularly clear that internal complexities of flaking technologies, variously identified and described as 'methods' or 'modalities' by French technologists, are largely irrelevant for reconstructing the bigger picture of hominin evolution he and his colleagues are interested in. This critique ties in with a general resentment to trends of 'complexification' in lithic research (e.g., Bar-Yosef and Van Peer 2009: 114; Shea 2013a: 3, 2017: xvii) and the perceived proclivity to fetishise – that is, 'reify' or 'essentialise' – technology itself (e.g., Shott 2003: 100, 2010; Tostevin 2011b: 359; Shea 2013b: 154, 2014).[36]

The French research enterprise is doubtlessly informed by a rather different body of theory. To paraphrase Clark, French practice 'relies heavily on concepts and ideas derived from ethnology and sociology and only little on those of biological anthropology, primatology, or cognitive neuroscience.' A close reading of the French literature reveals that most approaches are shaped by French cultural and sociological theory (e.g., Pigeot 2004; Bon 2009; Valentin 2011: 57; de Beaune 2016), the 'anthropology and history of techniques' (cf. Karlin 1991; Valentin 1995; de Beaune 2000, 2011), elements from philosophy of technology (cf. Geneste 2010 [1991]: 420-424), structural history (e.g., Valentin 2008, 2015; Audouze and Valentin 2010), as well as philosophy of life and cybernetics (e.g., Boëda 2005, 2013; Chevrier 2012). The French perspective to the past is anchored in the wider discourse of the humanities and remains sensitive to its intellectual currents.[37] This bifurcation of the theoretical landscape at the French-Anglophone interface suggests that 'social' or 'evolutionary' theory does not necessarily refer to the *same* body of theory, neither is the claim justified that French research generally lacks contact with the two. Thus, as Scarre (1999: 160) pointed out almost two decades ago, we 'should not expect French archaeological theory to be the mirror-image or mere adoption of the archaeological theory current in the Anglo-American world.'

These differences in the theoretical and, by extension, disciplinary fabric of French and Anglophone Palaeolithic archaeology can be traced in the labels deployed to name and identify the representatives of the two in the institutional circus. In the United Kingdom and the United States, the discipline tends to flag itself with terms such as *Human Origins*, *Palaeolithic Archaeology*, *Human Evolutionary Studies*, *Biosocial Anthropology*,[38] or *Evolutionary Anthropology*. French scholars, by con-

[35] The point here is not to marginalise the clearly existent differences between the types of approaches applied in the United States and the United Kingdom (e.g., Shott 2005), but rather to highlight that these differences are minor if compared to the differences apparently marking the French-Anglophone interface. The argument, in other words, is while lithic research in the U.K. and the U.S. is surely not identical the general level of affinity outweighs these differences when the two are confronted with French-type inquiry (see Chapter 4 for a demonstration).

[36] The basic point of contention here is whether past reality is best understood as a 'discrete' structure or as a 'continuous' field. One the one hand, it has been noted that French lithic analysts tend to study technology for the sake of technology and therefore 'reify' their subject-matter. On the other hand, it has been argued that the introduction of discrete interpretive categories, such as reduction stages (e.g., Baumler 1983; Dibble 1987, 1995a; McPherron 1994; Shott 2010, 2017) or named industrial entities (e.g., Shea 2014; Monnier and Missal 2014), has prevented the recognition of continuous variability in the lithic record. For the British insistence on 'continuous' reduction, see for example Scott (2011) and Pettitt and White (2012: 272).

[37] This general divergence in the theoretical and disciplinary sources that feed into French and Anglophone research respectively suggest that some of the conflicts that are observable at the interface of the two actually break down to the long-standing tension of either orienting the study of behaviour towards the natural and life sciences or towards the humanities and sociocultural sciences (cf. Corbey 2005; Slingerland 2008; Slingerland and Collard 2012).

[38] The case of 'Biosocial Anthropology' illustrates the basic clash of epistemologies that has presumably played a key role in the consolidation of the French-Anglophone boundary. This branch of research takes inspiration in the work of Fox (1975) and Tiger (1969) and is generally associated with a broader 'zoological turn' (Tiger and Fox 1966, 1971) that has transformed North American anthropology from the 1960s onwards (cf. Corbey 2005: 134-144). This approach to anthropology seeks to, *grosso modo*, base the latter on a comparative science of human economic behaviour based on quantitative science, rational choice theory, Darwinian evolution, and, as Fox pointed out himself (Walter 1993: 446f.), British 'empiricism' and 'utilitarianism'; it is also

trast, generally regard themselves as exponents of *« Préhistoire »*. The latter is typically subdivided into umbrella approaches, consortia of inquiry, or broader research agendas – i.e., *« Ethnologie préhistoire »*, *« Technologie préhistoire »*, or *« Paléohistoire »* – as well as the specialised C.N.R.S. laboratories tied to different university structures. With regards to lithic research, the resulting opposition could barely be more specific. In France, lithic analysts tend to specialise themselves into particular types of technologies and are recognisable as *« technologues »* or *« lithiciens »* (cf. de Beaune 2016: 58), echoing the conviction, paradigmatic for the French approach to technicity in general, that *technologie* constitutes an independent field of study (cf. Leroi-Gourhan 1936b) – the 'science of (human) techniques' (*sensu* Haudricourt 1987). In the Anglophone world, on the contrary, lithic analysis is conducted by a much more heterogeneous group of scholars, specialised in a variety of different disciplines and subfields.

This discrepancy in the self-recognition and intellectual background of French and Anglophone research endeavours is echoed in the publication venues characteristic of the two. While edited volumes and research monographs continue to be equally important in both research spheres, the journal landscape is markedly different. Not only is the range of high-profile, peer-reviewed journals fed by the Anglophone system much more proliferated and diverse, its architecture is also increasingly modelled on the natural sciences, quantitative social sciences, and the life sciences (see **Appendix I.3**). In France, the panoply of journals is comparatively narrow and unpublished, yet often extensive doctoral dissertations and habilitations play a much more crucial role in the dissemination of knowledge and the progression of research. These differences suggest that Palaeolithic knowledge production is indeed framed rather differently in the two research spheres.

In light of this broader divarication of approaches, it is perhaps no surprise that the relationship between French and Anglophone lithic inquiry continues to be difficult and that the offered critique tends to be increasingly structural. In this intellectual context, there is a strong temptation to wage disputes as partisan, as "win-at-all-costs ideological struggles" (Law 2015: 7). This temptation not only gives rise to more and more 'aggressive polemics,' it also encourages the construction of group solidarities that bind together 'insiders' and purge 'outsiders' (*idem*). The result is the cultivation and consolidation of differences between the involved communities of research, predisposing the perception of the 'other' in increasingly dismissive and/or hostile terms. All of this only deepens incompatibilities of inquiry, leading not just to a dysfunctional mode of engagement but also subverting the general capacity of mutual understanding. There is a heightened danger of basic forms of miscommunication and 'talking past each other.' French-Anglophone relations in Palaeolithic archaeology currently seem to experience such a crisis; while Anglophone scholars display increasingly zero-tolerance towards the kinds of approaches embraced by their French colleagues, the latter appear to be only little impressed by the criticism directed against them:

> "The increasingly multinational discipline of lithic analysis is currently undergoing a "culture contact" event between competing scientific traditions of studying the evolution of human behavior through the remains of stone tools. This academic culture contact has not been as productive as it should, as researchers advocating an American processual "reduction sequence" approach react with more resistance than informed engagement to the growth in popularity of the French "*chaîne opératoire*" approach among Europeans and other nationalities around the globe. Equally, *chaîne opératoire* advocates have seemingly turned a deaf ear to requests for improvements in the epistemological rigor of their method." (Tostevin 2011a: 293; original emphasis)

Overall, this configuration clearly suggests that the French-Anglophone divide puts much more at stake than currently meets the eye. There is a real need to dismantle these stakes in order to re-enable the discourse or to at least clarify why communication, a precondition for advancing lithic knowledge on a 'global' scale, is critically hampered. Clearly, the division between French and Anglo-

firmly rooted in the corroborative methods developed by Ayer and Popper, both of whom Fox met at the *London School of Economics*. This movement, which Fox (1975, 1989) later coined 'biosocial anthropology,' was a deliberate turn away from the humanities and qualitative social sciences: "[…] The sheer weight of evidence from the natural sciences will swamp the simple-minded ideology of social science. Soon it will be obvious even to the most recalcitrant cultural determinist that Durkheim and Boas – right as they were about many things – were essentially prescientific, and that their formulae were political adaptations fully understandable at the time but no longer binding on a better-informed generation. By that time, however, a new social science will have arisen, probably directly from natural science itself." (Fox 1989: 124). This vision of anthropological research is a direct *affront* against the cognitive orientation of French inquiry.

phone approaches is a reality of research and we should not take it lightly. A brief review of the French literature will substantiate this view.

1.2.1.3 *The French rejoinder*

The French response is hardly worth the designation, but we should not be mistaken that it is missing altogether. That the Anglophone critique, substantial as it is, somehow evaporates at the gates of the European mainland or is simply ignored altogether is equally unlikely. But why is there so little direct reaction to the issues raised by Anglophone researchers? One reason is surely that French scholars have long come to regard the Anglophone critique as an expression of conflicting 'schools' of research (e.g., Bon 2009: 199f.; Perlès 2016) and, consequently, tend to deal with it in rather general and less 'agitated' terms; the engagement only rarely takes place in specialised articles but is typically buried somewhere in lengthy monographs. The purpose of taking issue with the 'other' is mainly to situate one's own research or to discuss its epistemological point of departure. Given that French works are only rarely read or discussed in Anglophone research circles, this indirect response remains practically invisible. But there is also the firm possibility that the details of the Anglophone critique are either not fully understood or not taken completely seriously. Both prospects, although difficult to evaluate based on the literature alone,[39] certainly add to the gravity of the communicative gulf established by the French-Anglophone divide. At any rate, the point is that if we look close enough, the French counter-critique is equally poignant.

The majority of critical utterances either targets the legacy of the various 'New' archaeologies that shape Anglophone research since the 1960s or the so-called 'Neo-Evolutionist' school. The critique is explicitly directed at 'Anglo-Saxon' research and typically serves to highlight the stark antagonism between French and Anglophone approaches to the Palaeolithic. This tendency of lumping U.S. American and British research traditions into a single category and to define the latter by negative reference to the prevailing French perspectives indeed suggests that 'Anglo-Saxons' are conceptualised as 'outsiders' or at least as cognitive 'others'; this, in turn, provides further indication that the French-Anglophone divide is a real-world phenomenon, perceived and approached as a true cognitive barrier.

French scholars have primarily taken issue with what they recognise as the 'typological-descriptive' baseline of lithic studies in the Anglophone world (e.g., Boëda 1991, 1997)[40] and the one-sided 'environmental' and/or overly 'deterministic' perspectives tied to it (e.g., Bon 2009; Langlais 2010). Perlès (1992: 223) has given a sharp voice to the first point by contending that

> "[...] the role played by lithic industries in the so-called new approaches in archaeology has proved very limited. For the most part, lithic studies have remained basically descriptive in their nature or they have limited their role in archaeological inference because they have approached lithic variability from a purely typological perspective."

She (*ibid.*: 224) adds that the Anglophone preoccupation with formal 'hypotheses-testing' in the hope to reveal the most potent explanatory factors has shrouded the view for the inherent complexities of lithic industrial variability:

> "[...] [T]hese approaches are too restricted for an efficient analysis of archaeological contexts in which lithic industries, their variations, and their transformations result, as do all human phenomena, from the interaction of multiple factors."

[39] The desideratum here would be to conduct systematic ethnographic and sociological research on the perception and understanding of French-Anglophone relations in Palaeolithic archaeology; this perspective obviously goes beyond the scope of the present study.

[40] The general discontent about 'typological reasoning' which prevails in the French tradition since the 'technological turnover' initiated by Tixier and his early Parisian collaborators has recently been refined into a resolute epistemological critique by Boëda and others. Proponents of the 'techno-genetic' paradigm (see Chapter 5 for a detailed exposition of this perspective) have taken issue with the 'static' conception of technical objects implied by typological and taxonomic reasoning alike. Drawing on Simondon's (1958) general philosophy of technical objects, Boëda (2013: esp. 28f., 38) has launched a sharp attack on the *hylomorphic* interpretation of shape-differences in lithic artefacts (this issue will be taken up again in Chapter 6).

Another recurrent theme of contention, linked to the pending issue of 'environmental determinism,'[41] is the Anglophone recourse to generalities and/or universals of behaviour transcending the boundaries of space and time:

> "Above all, demographic growth might partly explain the restructuring of social performances. This perception is strongly influenced by the Anglo-Saxon tradition, especially American, whose Neo-Evolutionist school long considered demography as one of the main drivers of the transformation of human societies. [...] But among these works, numerous hold that this demographic factor is closely linked to environmental variations. Regardless of its possible connections with demography, the theme of environmental conditions is of great concern to Anglo-Saxon schools, and their influence is decisive in this domain, both in the affirmation of the importance of this topic and in the way it is addressed. For a long time now, many of these schools have articulated their intellectual approach around the search for models of a general bearing: they elaborate a predictive model, most often inspired by contemporary situations whose degree of application to the archaeological context must be measured. This method is based on the assumption that universal behaviours are able to transcend temporal barriers and can be identified as such. Among these universals, the emphasis is very often put on the relation between humans and their environments in terms of a relatively strict determinism. In other words, the development of a model for exploiting the environment based on the confrontation of current ethnological contexts serves to interpret archaeological data, the compilation of which enables them to confirm – or not – a pre-established hypothesis. This intellectual orientation is expressed in particular by the *New Archeology*, created in the 1960s based on these principles. This hypothetico-deductive take is opposed to the most common approach in Europe, and particularly in France, which may be qualified as inductive: the collection of facts is supposed to precede the development of models, and not to respond to a preconceived idea." (Bon 119f.; my translation [for the original French quote, see **Appendix Q.5**]).

Perlès (2016: 222) makes a similar point when she concludes that

> [...] the divorce rests even more on methods and aims. In North America, the elaboration of interpretative models always seeks, in fine, to bring to light transcultural and transchronological regularities, validated, if possible, on formal or quantitative models. In France, to the contrary, research on technical variability has been mostly tuned to demonstrating the singularity of each (pre)historic regional development. In addition, the hierarchization of the different parameters under study, based on a qualitative evaluation, impeded any global statistical treatment, however complex."

The French tradition, in sync with interpretive ethnology, has cultivated a general scepticism towards all forms of 'universalist' reasoning, seeking to detect and, if possible, unmask 'otherness' in the archaeological records. This cognitive inclination can be traced back to the work of Leroi-Gourhan (1983a) who powerfully cautioned against the overly optimistic use of substantial ethnographic parallels, preferring more abstract and ultimately structural invocations of anthropological insights. It is a classic trope of French thought to insist on the particularities of past lifestyles (cf. Perlès 2016) and to conceptualise the societies under study as 'fossil' (e.g., Bon 2009) – that is, as potentially lacking revelatory historical or sub-historical correlates. Approaches that rest on the presumption of significant past-present continuities or presuppose particular concepts of rationality and the like are therefore easily labelled as 'naïve.' They are regarded to critically underestimate the complexities of past phenomena and to fall back to various forms of 'reductionism.'

The environmental perspective regularly employed by Anglophone scholars is seen with great caution because of the same reasons. French researchers exhibit a general resistance against ecological reductions not because they think the environmental context is irrelevant, but rather because they doubt that a direct, un-mediated link between human and natural domains can be consistently upheld (e.g., Boëda 2005: 46; Bon 2009: 119f.). Stressing the constraining or determinative effects of ecological factors always risks to remove any leeway for human action and creativity – a leeway that one must realistically presume (cf. Valentin et al. 2005; Langlais 2010; Valentin and Bon 2012; Marchand 2014: 109f.). This contention culminates in the straightforward rejection of any account putting primary explanatory weight on environmental variables. Especially approaches based on purportedly 'mecha-

[41] See for example Livingstone's (2012) insightful exposure of the at times 'brute' environmental determinism that features in some of the main narratives about hominisation and early human evolution in the Anglophone discourse. Livingstone (*ibid.*: 583-585) refers primarily to the influential work of Vrba (1985, 1993, 2006), Potts (1996a, 1998), Finlayson (2004, 2009), and Stringer (2006) in order to show that modern *Human Origins* research is often guided by the premises of an emerging 'neo-environmental determinism' (cf. Meyer and Guss 2017), exhibiting conceptual continuities with early-twentieth-century approaches.

nistic' conceptions of human-environment relations tend to be out-rightly repudiated (e.g., Perlès 1993; Boëda et al. 2001; Boëda 2013: 87-88) – an apprehension that is directly reflected in Bon's (2009: 120, 122-125) exemplary discussion of the problematic relationship between lithic technologies and their natural milieu. After having explored some patterns of technology-environment co-variation, he offers the following words of caution:

> "However, a *mechanical* relationship between these environmental changes and changes in the lithic equipment should be considered with prudence." (Bon 2009: 179; original emphasis; my translation [for the original French quote, see **Appendix Q.5**])

and

> "[...] there is no one-sided equation between a type of lithic armature and a given natural environment." (*ibid.*: 182; my translation [for the original French quote, see **Appendix Q.5**])

Although the connoted critique of 'Anglo-Saxon' approaches certainly involves a high degree of 'stereotyping' and 'caricaturising,' the general message is clear. French scholars are dissatisfied with the basic picture of the past that emerges from the bulk of Anglophone research into the Palaeolithic. They take issue with the circumstance that Palaeolithic life is primarily portrayed in its dependency on external material conditions, creating an interpretive matrix in which the 'struggle for survival' overrides most other perspectives or interpretive concerns.

Another strand of criticism, rather explicit in content and orientation, addresses the 'basal character' of most Anglophone enunciations. Marchand (2014), after taking stock of Anglophone writings of the post-1960s, for example contends that the central message has too often been redundant and perhaps even tautological. He (*ibid.*: 103) explicitly laments the tyranny of *deus ex machina* accounts and the latent 'truism' and 'triviality' inherent to many 'processualist' explanations (*ibid.*: 103-111). The point of contention is whether the finding that hominin behaviour is broadly conditioned by its ecological framing amounts to a substantial discovery. In the view of Marchand and others, this question must probably be answered negatively since all organisms have to relate adaptively to their natural surroundings. To conclude that lithic inventories broadly reflect their environmental framing is to say nothing new, it is a superfluous reinforcement of something that needs to be presumed anyways. Marchand (2014: 103) adds that the default prioritisation of environmental constraints in explanatory strategies almost automatically leads to the marginalisation of historical forces which have undoubtedly shaped the Palaeolithic past, and thus to an image of Palaeolithic people essentially 'devoid of history:'[42]

> "The consequence of [Binford's *New Archaeology*] in the study of the European Mesolithic during the 1980s and 1990s was – regrettably – the inevitable conclusion of all articles that the society was adapted to its environment and the site was located at the crossing of diverse ecological niches... The deformation of the principles of processual archaeology, after all otherwise fruitful, finally impelled research on past hunter-gatherers without the dimension of history: an escalation! In fact, the notion of adaptation must not be applied without searching the means to demonstrate it, otherwise it leads to a stiff vision of changes [Bettinger 1987]." (my translation [for the original French quote, see **Appendix Q.6**])

The forceful denial of 'first-mover' conceptions, 'selectionist' or 'adaptationist' agendas, and the notion of human-environment 'autoregulation' reveals an even deeper-running offset between French and Anglophone modes of inquiry. The key issue is fundamentally epistemological: whether practitioners should look for and map 'relationships of match' or instead be perceptive to 'patterns of mismatch.' Since the 'environmentalist' perspective tends to focus exclusively on the former, it can easily overlook the latter. Yet evidentiary mismatches may be at least equally informative than the

[42] French *« Paléohistoire »* departs from this basic point of contention. It entails a tacit critique of the fixated and immutable image of hunter-gatherers which is too often imported to the study of the Palaeolithic past. 'Palaeohistorians' insist on the fact that past foragers have a history of their own – a history that must be assumed to have fundamentally shaped their existence and development (e.g., Pigeot 2004: 255f.). Valentin (2008: 14, 15f., 20, 22-26,, 2011: 3), for example, complains about the circumstance that the label 'prehistory' almost by default encourages the view that Palaeolithic phenomena are somewhat different in nature from those of 'history.' Palaeolithic studies, according to this point of view, must emancipate themselves, they are not merely the 'antechamber of prehistory' (*sensu* Bon 2009; cf. Valentin 2008: 28).

successful correlation of data, especially if we consider 'conflict' as an important coordinate of past realities.[43]

This critique has notably been put forward by Boris Valentin (1995: 791, 2008: 41) who, based on some basic source critical considerations, outlined the dangers of blind 'correlationism,' in particular when the eco-climatic context of the lithic evidence is concerned.[44] His voice reflects a growing concern about careless strategies of pattern recognition and the tendency to assess lithic technology in its 'heteronomic' constitution. The last critique is shared by many French scholars and is epitomised by agenda-setting movements such as *« Paléohistoire »* in the wake of Valentin, Bon, Marchand and others (cf. Valentin 2015) as well as by the 'techno-genetic' paradigm forged by Boëda (2005, 2013) and his co-workers.

A last but persistent antiphon to Anglophone lithic inquiry is the dismissal of overly or even purely quantitative approaches. This theme already features in Perlès' comparison of French and Anglophone perspectives on the lithic record quoted above.[45] As this author has stressed again and again (e.g., Perlès 2016: 224f.), *chaîne opératoire* inquiry is based on a fundamentally 'qualitative' understanding of technology, which makes it difficult and sometimes even impossible to quantify its inferential touchstones.[46] Pelegrin (2006b: 40) makes the same basic remark when he insists that

> "[...] for the diagnosis of knapping techniques a technical understanding of fracture based on systematic experiments is more effective than complex statistics."

Perlès' (2016: 255) brief discussion of Bar-Yosef and Van Peer's (2009) critical engagement with *chaîne opératoire* methodology, a rare example of a direct response by a French scholar to a severe Anglophone attack, takes up the qualitative nature of French technological inquiry to deflect the raised charges. Perlès (2016: 255) contends that those who wish to base 'every single interpretive proposition on quantitative grounds' or even 'on criteria generally exploitable by anybody' miss the crucial point that technical understanding is necessarily rooted in referential knowledge and personal experience, epistemic factors impossible to equalise through or bypass by quantification of similar procedures; she (*idem*) further contends that part of the offered critique similarly applies to Anglophone approaches based on 'design theory' in the wake of Bamforth, Bleed, and others, and in addition reproduces the old, untenable Binfordian image of Neanderthals lacking the capacity for foresight or conceptualisation. The basic point, however, remains that an inherently qualitative approach cannot be invalidated by arguments that presuppose the necessity of a quantitative foundation.

This response showcases again how much confusion the French-Anglophone divide has apparently created; it reminds us that researchers from the two camps may be guided by very different norms of inquiry and are therefore greatly predisposed to employ 'double standards' (*sensu* Roebroeks and Corbey 2001; Corbey 2005) when they critically engage with one another; the result, again, is a heightened risk of 'talking past each other,' sabotaging the prospects of knowledge exchange and effective borrowing.

To summarise, French lithic experts are surely not the passive victims of Anglophone criticism that some would have them to be. Rather, the French tradition has launched its own attack on the very foundations of Anglophone lithic inquiry and although this attack is somewhat less explicit and more difficult to pinpoint, it is equally self-assertive as its Anglophone counterpart. Despite the fact that an open confrontation between the two research spheres has not erupted yet, the conflict is certainly 'hot' and seems to operate on the level of research communities. However, the engagement between the two involved 'collectives of thought' appears to be rather asymmetric and the rhetoric of engagement be-

---

43 The idea of 'conflict' is central to French attempts to overcome the picture of past hunter-gatherers as 'noble savages,' completely 'fusing' with their environments – a view considered 'simplistic' at best (cf. Marchand 2014: 110). From this perspective, it is also tempting to regard the search for human-environment equilibria as a tacit acceptance of the romantic notion of foragers living in harmony with nature.

44 See also Marchand (2014: 109f.).

45 Cf. Perlès (2016: 225).

46 This deeply sedimented mistrust in quantitative approaches, opening up a stark contrast with Anglophone research traditions (e.g., Clark and Stafford 1982; Lycett and Chauhan 2010), is nicely illustrated by Plutniak (2016: 230). As Plutniak (*ibid.*: 46) outlines, the case of Catherine Perlès is particularly revealing since she initially followed some the seminars given by Benzécri, the author of *Analyse des données* (1968), in Paris and attempted several statistical examinations of lithic artefacts with his method, eventually abandoning the quantitative perspective because it didn't help in discriminating hierarchised and potentially complementary technical relationships. In her view, the ability to detect 'intentional facts' seems to be generally compromised already by the default assumption of most quantitative-statistical approaches that the nature of the objects of study does not matter much (cf. Dreyfus 1975).

comes easily dismissive and even hostile. There is also evidence that fundamental misunderstanding and regular 'talking past each other' heat up the major axes of conflict. In the extreme, disagreement even serves to fuel scholarly self-recognition and helps to legitimise particular approaches, indicating that French and Anglophone research endeavours construct part of their identity through negative reference to one another. The overall pattern, therefore, is clearly consistent with a cognitive chasm.

All of this begs the question of how exactly lithic knowledge is produced and secured in both research contexts. One may also ask what the tangible consequences of the divide for particular cases or items of research are. The last issue will be explored in some detail in the next section. It will help us to understand why the divide is not just of theoretical or epistemological interest but has important practical ramifications, rendering it highly relevant for scholarly discussions in the field.

1.2.2 ***Three cases of practical underdetermination***

We can learn a great deal about the nature of the conflict if we zoom in to the practical realities of research and examine actual cases in which the lithic knowledge claims put forth by French and Anglophone scholars appear to clash. If we wish to evaluate the status and bearing of critical disagreement at the French-Anglophone interface, it seems useful to pay particular attention to cases of interpretive discord in which the objects of study are relatively similar. By keeping the object matter as constant as possible, it becomes easier to chart and discuss the epistemological sources of interpretative divergence. The three paired case studies that are investigated in this section have been chosen according to this logic: each pair deals with the same material basis – a well-defined collection of lithic artefacts – but hosts two largely inconsistent knowledge claims about it; the deviating interpretations are offered by well-respected representatives of the two clashing spheres of research. This comparative strategy should allow us to evaluate whether and to what extent lithic knowledge claims are underdetermined by the available evidence, illustrating the crisis of lithic knowledge that becomes manifest at the French-Anglophone boundary; it responds to a general desideratum that lies dormant in the literature for quite a while now (e.g., Wylie 2002: Part I), but has never really been taken up in Palaeolithic archaeology – to take serious the intricacies of case-based practices and the many difficulties of research arising from them:

> "What is needed, we suggest, is resolutely case-based analysis of actual practice – key instances of exemplary practice, critical turning points, innovations, and instructive failures in the use of archaeological data as evidence – aimed at making explicit the norms of evidential reasoning that have taken shape in the context of evolving traditions of practical experience working with archaeological material." (Wylie and Chapman 2015: 7)

The three selected case studies represent 'key instances' of critical disagreement at the French-Anglophone interface; they showcase that even a shared evidentiary baseline is often not sufficient to ensure broad interpretative convergence. The paired case studies centre on the lithic assemblages from (i) Biache Saint-Vaast level IIA; (ii) Gouzeaucourt G; and (iii) Kulna 9b, 7, 7c, 7a, and 6b, respectively (**Tab. 1**; see **Appendix I.2** for a detailed exposition of the rationale guiding the selection of case studies). The first case confronts the original interpretation of the Early Middle Palaeolithic assemblage from Biache Saint-Vaast level IIA by Boëda (1988) with Dibble's (1995a) re-analysis of the same assemblage a few years later. The second case compares McPherron's (1994) analysis of bifacial technology at Gouzeaucourt G with Soriano's (2000) treatment of the same material corpus, forming a central part of his celebrated doctoral dissertation. In the third case, Boëda's (1995a, 1995b) early technological assessment of the interaction between Discoid and bifacial technologies in the Micoquian layers of Kulna cave is opposed to the more recent characterisation of the lithic material by Tostevin (2000, 2012). These examples are 'Paradigm cases' (*sensu* Scholl and Rätz 2016) of their respective research traditions: occurrences that can be regarded as "more or less typical instances of some aspect of [the] science [under consideration]" (*ibid*.: 78). As such, they should help us to chart some of the most pertinent practical effects of the French-Anglophone divide, and consequently put us in a better position to gauge the latter's potential bearing on the problem of lithic knowledge in the field.

All original studies have been published between the late 1980s and early 2000s, the only exception being Tostevin's *Seeing Lithics* (2012) which, after all, is basically a revamped version of his doctoral research conducted in the late 1990s (Tostevin 2000). The chosen timeframe is not coincidental;

it bespeaks of a critical period for the development of both research spheres, in which French researchers established the 'technological approach' and Anglophone scholars began to gradually free themselves from the shackles of the 'Binford-Bordes debate' elaborating new perspectives on the lithic record. The cited studies can count as important cornerstones of these developments. They remain influential in their respective discourse formations, some of them assuming a status as 'research prototypes.'

Boëda's (1988) examination of the Biache level IIA assemblage furnished the classic definition of 'Levallois recurrent' (cf. Boëda 1994) and his technological reading of the Kulna Micoquian resulted in the first 'volumetric' definition of Discoid technology and a highly influential approach to aspects of functional design in bifacial tools (Boëda 1995a; 1995b), providing some new perspectives on *débitage-façonnage* complementarities (cf. Boëda 1991). Soriano's assessment of the lithic evidence from Gouzeaucourt G, part of a more extensive comparative study, carries on this legacy yet also reflects an increasing concern with the morpho-functionality of lithic tools in the French scene, delivering an important methodological impulse for emerging stands of 'UTF-analysis' (e.g., Lepot 1992/1993; Boëda 1997, 2001; Soriano 2001, 2005).

The Anglophone research instances played a similarly potent role. Dibble's (1995a) re-examination of the lithic assemblage from Biache Saint-Vaast level IIA is commonly viewed as a demonstration of the 'reduction thesis,' highlighting the proficiency of attribute analysis. McPherron's (1994) comparative investigation of bifacial shape variability conveyed a basic understanding of varying reduction trajectories and their morphometric effects and may count as a forerunner of complex statistical applications in the field; this work remains significant also because it formulated a compelling critique of cognitive readings of lithic shape differences (cf. McPherron 1999, 2000; Iovita and McPherron 2011) – effectively extending Dibble's (1987) scraper reduction model to bifacial technology. Tostevin's (2000) study of the Late Middle Palaeolithic assemblage from Kulna was instrumental in coining his widely recognised 'behavioural approach' to lithic technology (cf. Tostevin 2011b, 2012), propelled by the middle-range concept of 'taskscape visibility' (Tostevin 2007; Premo and Tostevin 2016). In fact, Tostevin is sometimes celebrated as the pioneering figure of the 'better' *chaîne opératoire* approach.

The selected cases should therefore prove useful in exploring the underdetermination thesis in lithic analysis. We can compare the main results of each pair and assess the degree of cognitive incompatibility, if any. This should allow us to determine some of central points of interpretative friction characterising the French-Anglophone interface in lithic research. This assessment, in turn, should provide us at least with some clues on the nature of theory-ladenness in both research spheres. How serious, then, should we take the division between French and Anglophone approaches in lithic analysis?

1.2.2.1 *Comparing the fruits of French and Anglophone lithic inquiry*

The juxtaposition of the main assertions respectively put forth by French and Anglophone practitioners in the three cases of interest demonstrates that the discord in lithic knowledge yields is rather substantial (**Tab. 2**). Not only is there little overlap in the contents of lithic knowledge claims, the devised interpretive statements are often oppositional and tend to exclude each other. The paired cases almost read like staged disputes in which each weighty proclamation is negated and countered by an antithetical proposition through the opponent, only to be counteracted again by the initial proclaimer and so forth. All cases host two readings of essentially the same lithic sources emphasising completely different features and aspects of technology and fail to establish any far-reaching common ground.

In the case of Biache Saint-Vaast level IIA, the authors primarily disagree on whether the assemblage harbours multiple, conceptually distinct reduction sequences or whether the knapping process has to be described as generally continuous and flexible. While Boëda (1988) discriminates between five reduction schemes ('A'-'E') with a specific sequential logic and implied technicality, Dibble (1995a) rejects the hypothesis of discrete reduction trajectories and finds that modalities of reduction change as a function of reduction depth. Furthermore, the former elaborates three stages of flake production tied to uni- and bidirectional 'Levallois recurrent' ('Schemes A' and 'B'), the two primary methods of reduction that he identifies; these stages supply a differential pool of primary blanks and by-products. The latter, by contrast, holds that what the former recognises as uni- and bidirectional Levallois does not differ in any single measure (attributes, metrics); a more likely explanation – given the general correlation between size, cortex ratios, platform facettation, and scar-pattern – is therefore that core treatment was strategically adjusted during a core's life history.

Whereas Dibble (1995a) concludes that blank-tool relations are only weakly developed and that the main blank selection factor appears to be blank-size, Boëda (1988) ascertains that the overall technical structure of Levallois reduction supports well-defined blank-tool relationships; he argues that blank selection is foreshadowed by the spatiotemporal organisation of the technical systems in question and the respective blanks that occur at different stages of the knapping process. Finally, Boëda interprets the lithic evidence as testifying to a well-developed technical 'know how' (*savoir faire*) indicative of a particular 'technical tradition;' Dibble, on the contrary, contends that the documented lithic variability is likely driven by basal (physical) reduction effects, raw material availability, and other eco-environmental constraints.

The example of Gouzeaucourt G illustrates that French and Anglophone researchers may easily contradict each other when they interpret variability in lithic artefact shapes and other physical variables. McPherron (1994) proposes that morphometric differences within the bifacial assemblage are only poorly understood by invoking distinct construction plans and rather reflect the allometric interaction of various shape-variables on a given reduction trajectory. His point is that certain morphometric features of the Gouzeaucourt bifaces naturally co-vary as a function of reduction depth and reduction intensity. The author concludes that bifacial reduction engenders a directed pattern of shape transformation, with pointed forms generally signalling less reworking of an object and rounded forms resulting from a more intense consumption of raw material. Soriano (2000), conversely, holds that bifacial shape differences, although also subject to reduction effects, are anchored in distinct schemes of constructing, maintaining, and handling bifacial tools. Shape is regarded as an emergent factor of specific technological strategies, involving particular modes of volume construction, edge rejuvenation, and settlement organisation. Soriano's central claim, contrary to McPherron, is that bifaces cannot be sufficiently understood if analysed in isolation but need to be first placed into their larger context of technicity; he argues that the bifacial technology of Gouzeacourt G represents a complementary strategy to the co-existing, relatively simple flaking technology – the relationship between the two is diagnosed to be synergistic.

Thus, McPherron (1994) primarily emphasises that there is no reason to believe that bifacial variability is tied to broader regional or chronological trends and suggests that documented patterns of inter-site variability are likely to reflect localised circumstances, including differential histories of site-occupation. By contrast, Soriano (2000) explicitly places the evidence into a larger evolutionary sequence, suggesting that the specifics of *débitage-façonnage* interaction are the result of a changing status of bifaces from the Lower to the Middle Palaeolithic; he considers these developments as closely bound to more general changes in the spatiotemporal organisation of *chaînes opératoires* in this timeframe.[47] Ultimately, McPherron seeks to ground the observable bifacial variability in the physical constraints inherent to bifacial technologies and strongly criticises overly cognitive explanations, whereas Soriano regards the conceptualisation of bifacial reduction within its larger technological context as key; the latter further stresses that the bifaces from Gouzeaucourt G index a particular 'technical culture.'

The case of the Micoquian assemblages of Kulna cave combines some of the contentious points encountered in the previous two examples. First of all, the accounts of Boëda (1995a, 1995b) and Tostevin (2000, 2012) reproduce the bifurcation of 'discrete' and 'continuous' readings of lithic technology. While the former posits that Discoid technology is generally characterised by a well-defined technical rule-set bringing into existence four highly diagnostic blank-types and asserts that in the Kulna assemblages two distinct methods of Discoid production can be attested, the latter finds that lithic reduction is continuous and changes in a directed manner – from (sub-)centripetal over unidirectional to crossed modalities of reduction – in the course of core exploitation. This difference also becomes

[47] The topic of bifacial mobility may represent a tacit point of convergence between the two authors since the idea that technology is regulated by patterns of hominin movement is generally consistent with both of their reasoning. However, even though Soriano (2000: 349-354) explicitly discusses the issue of techno-mobility in his work, he clearly considers mobility to be subjected to sociocultural choice and hence as something that presupposes conceptualisation and requires both technical and cognitive anticipation. It is unlikely that McPherron (1994) would accept this viewpoint.

manifest in Boëda's insistence on the presence of two separated *chaînes opératoires* – a finding that is plainly opposed by Tostevin's characterisation of the Kulna material in terms of a single generic reduction sequence; the latter explicitly maintains that the assemblage represents a 'palimpsest of technological options' and consequently has to be understood as a product of the "cumulative efforts of past flintknappers" (Tostevin 2012: 162). The continuous and directed vision of reduction championed by Tostevin is in turn countered by Boëda's exposition of Discoid technology as a self-stabilising structure typified by a recurrent and cyclical pattern of volume management.

The second major issue is that the two authors disagree on the importance of bifaciality in understanding the Micoquian technology from Kulna. Whereas Boëda (1995a, 1995b) proposes that *débitage* and *façonnage* represent two complementary systems of tool manufacturing but yield tool matrices of different sizes, Tostevin (2000, 2012) sees the bifacial tool component mainly as an expression of a rather diversified tool-kit and highly reduced lithic objects in general. In fact, Tostevin attempts to link this latter circumstance to factors of raw material availability and hominin mobility; Boëda, by contrast, argues that the high reduction potential of Discoid systems is a consequence of their technical logic. In the end, the former claims that Kulna technology as a whole reflects a set of learned behaviours designating a specific 'technological style' with a specific place in the Central European sequence of technological evolution, while the latter identifies the Kulna Micoquian as a regional entity of the European Late Middle Palaeolithic hosting a specific 'know how' (*savoir faire*) and exploiting merely a number of the options available to the *courant technique* ('technical current') of the wider Micoquian phenomenon.

These three cases demonstrate that a consensus is currently illusional. Even when individual findings seem to converge – for example the Discoid cores of Kulna which are interpreted by both Boëda (1995a) and Tostevin (2000, 2012) as signalling intensified lithic reduction – they are evaluated rather differently or are linked to disparate sets of contextual evidence. In total, the three paired cases of conflict suggest that the French-Anglophone divide has not just a general bearing on the vision of the field and the broader narratives of the Palaeolithic past it authors, but brings forth very specific differences in how the lithic evidence of particular sites or assemblages is handled and interpreted. These differences clearly warrant closer investigation. They are alarming insofar as they appear to be patterned – that is, similar issues surface again and again – and we currently possess only little insight into the basic sources that produce them. Furthermore, since the evidentiary basis does not differ much in the three cases, the strong polarity of interpretive outcomes may be taken to suggest that different *interpretive standards* are at work – interpretive norms that are fed by two historically grown yet distinct communities of research.

To conclude, the three case studies of lithic practice at the French-Anglophone interface point to a general state of affairs in which key interpretive choices remain underdetermined insofar as the lithic evidence presently available to practitioners, taken by itself, does not direct us to accept one viewpoint over its rival. Therefore, the French-Anglophone interface may be recognised as a venue at which the problem of lithic knowledge becomes particularly apparent; the French-Anglophone divide seems to embody a serious crisis of lithic knowledge production – a clash of varying 'styles of reasoning' (*sensu* Fleck (1979 [1935]) – that researchers are currently unable to satisfactorily address or navigate. Furthermore, the direct comparison of French and Anglophone knowledge yields has made it clear that the gravity of the division is difficult to negate and that, in order to properly understand it, a detailed exposition of the interpretive standards that orientate lithic analysis in both research contexts is required; we have to develop a basic understanding of the epistemological presumptions that direct lithic inquiry in both research spheres and explore how these interact with the evidence presently available. What follows in the subsequent chapters is dedicated to this end. Yet, a few words on the issue of 'critical practice' seem to be in order before we can begin to unpack the divide.

1.3 **Critical practice beyond partisanship**

The previous section has shown that the French-Anglophone boundary not only effectuates conflicting lithic knowledge claims but often erects a cognitive barrier complicating communication and mutual criticism; mischaracterisation and 'talking past each other' appear to be much more widespread than usually assumed. They both nurture a growing frustration in the face of obvious but largely intangible tension between French and Anglophone quests for lithic knowledge – fostering cognitive entrenchment and mutual exclusion. As noted before, this situation may easily lead to partisan disputes in which not negotiation but self-assertion emerges as the primary objective. The problem, then, is that conflicts in lithic knowledge production are likely engrossed over time and disagreement may quickly become a question of research ideology rather than something that is scrutinised and constantly renegotiated. If we wish to avoid that dogmatic tendencies assume command over the field, such 'immunisation' of viewpoints must obviously be prevented. It is therefore of critical importance that the dialogue between the two camps is re-enabled again.[48] All of this makes clear that the French-Anglophone divide has some important ramifications for practices of criticism in the field, especially if we take seriously into account that the clashing communities of lithic research may be instructed by fundamentally incompatible standards of knowledge formation.

Although we can easily agree on the fact that a 'critical attitude' appears to be central to the success and advancement of almost any research enterprise, it is often overlooked that 'being critical' is at least as challenging as assembling and interpreting evidence. Each 'problem of evidence' is typically tied to an associated 'problem of criticism.' In the face of substantial knowledge conflicts, there is a real threat that criticism aims primarily at the denunciation of cognitive contenders rather than seeking to enable and 'fuel' a productive discourse. When criticism is levelled for its own sake and contending research communities battle for prerogatives of interpretation, critical practice may easily mutate into a mere 'bashing' of non-shared viewpoints. This tendency, in turn, can redirect criticism entirely towards the 'other,' thereby foreclosing the need to be self-critical and to equally scrutinise like-minded peers. The current situation at the French-Anglophone interface gives us reason to suspect that critical practice in this sense may be considerably compromised.

As a matter of fact, even the practice of devising critical claims about rival viewpoints is not without preconditions. Broadly speaking, criticism can only be effective if the 'problem of evidence' that the criticised perspective initially intended to address is adequately captured; this implies that critical practice must respect at least some of the premises on which 'other' viewpoints are based. If it doesn't, critical utterances may easily spawn figures of mischaracterisation and consequently miss their mark. The general lesson is that 'being critical' requires a basic understanding of the cognitive 'other' and the epistemological framework from which rival knowledge claims derive. The preliminary survey of critical practice at the French-Anglophone boundary clearly suggests that such basic understanding is presently lacking.

Notwithstanding that we will return to the issue of 'critical practice' in the last chapter of this study – after we have explored the nature of the French-Anglophone divide in more detail – it should have become clear by now that the divide matters not only because it has generated a condition in which practitioners have great difficulties of coming to terms with divergent knowledge claims, but also because it potentially puts at risk critical practice in the field. The only way to help navigating and perhaps eventually overcoming this situation is to expose the conceptual underpinnings of French and Anglophone approaches as well as to analyse the pertinent sources of mischaracterisation and 'talking past each other.' A natural starting point is a survey of the main cognitive tendencies persisting in Western thought in order to retrieve an effective conceptual toolkit for the examination of the 'underdetermination thesis' of lithic knowledge at the French-Anglophone boundary. For reasons outlined in the next chapter, I draw on philosopher Stephen C. Pepper's notion of 'world hypotheses' to develop this broader conceptual framework. Pepper will help us to fill the 'underdetermination thesis' with content and to sharpen our grasp for the standards of knowledge formation and criticism presumably guiding lithic inquiry at the French-Anglophone interface.

[48] This contention does not necessarily imply that we should strive for a 'middle-ground' – whatever it would look like – but simply reminds us that open engagement and honest interaction, critical as they must be, remain some of the essential building blocks of any 'healthy' field or discipline.

Chapter 2

Pepper's four world hypotheses as an epistemological framework to examine the divide

> *"If we desire to be undogmatic, and unexposed in the rear of our cognitive endeavors, we must be prepared to change our minds about the reliability of any evidence whatever. Facts do not guarantee our hypotheses. Facts and hypotheses cooperate to guarantee the factuality and the truth of each other. Cognitive enterprises open in a field of uncriticized fact. How much of this field will remain unaltered as a result of critical scrutiny, one cannot risk stating in advance. A constant recollection of this field of uncriticized fact, which quite correctly every hypothesis tries to abandon, is the greatest insurance against the fallacies of dogmatism."*
>
> – Stephen C. Pepper (1935: 367)

Abstract

This chapter introduces American philosopher Stephen C. Pepper's *World Hypotheses* (1942) as a viable framework for understanding research conflicts, which provides the key concepts for the comparison that follows. I start with a short discussion of why Pepper is useful for the task at hand and why his perspective offers some advantages that other available epistemologies of science do not. I then turn to the general structure of Western thought outlined by Pepper in order to expose the characteristics of its four cognitive pillars – 'formism,' 'mechanism,' 'contextualism,' and 'organicism' – including the dynamic interrelationships that exist between them. These four 'world hypotheses' disagree on the fundamental nature of reality and its essential building blocks; each of them musters a different repertoire of concepts and ideas for examining the empirical evidence. There are two 'analytic' theories – 'formism' and 'mechanism' – and two 'synthetic' theories – 'contextualism' and 'organicism.' The 'analytic' theories seek to understand reality from the perspective of parts and regard wholes as derived entities. The 'synthetic' theories, by contrast, recognise wholes as primary and view parts as dependent entities. The other two sets of two theories form the 'dispersive'-'integrative' boundary. The two 'dispersive' world theories – 'formism' and 'contextualism' – seek the proliferation of fact, regard reality as weakly determined, and try to take into account as much evidence as possible. Conversely, the two 'integrative' theories – 'mechanism' and 'organicism' – prefer a highly focussed reading of the evidence, regard reality as strongly determined, and more consequently discriminate between relevant and irrelevant information. Each of the four world theories provides a vastly different cognitive orientation, even bringing forth its own theory of how to assess and secure corroborative truth: 'formism' supports a correspondence conception of truth; 'mechanism' promotes a causal-adjustment theory of truth; 'contextualism' encourages an operational theory of truth; and 'organicism' champions a coherence conception of truth. Altogether, Pepper's four-partite epistemology delivers a powerful means to understand the nature of underdetermination in specialised fields of inquiry and helps us to recognise the principal coordinates along which knowledge conflicts are likely to occur.

2.1 **Why Pepper?**

Before we can start exposing Stephen Pepper's epistemological framework and to render it fruitful for analysing the French-Anglophone divide in lithic studies, a few comments on my motivation to draw on Pepper's work are in order here. Given that Pepper's contributions to the metaphysics of thought and the philosophy of science have largely been forgotten, the value of his work is not self-explanatory (see **Box 4** for a biographic note on Pepper). It has to be said, however, that this situation is in principle also no reason to not consider him. Just because he is not as routinely called upon as thinkers such as Kuhn, Popper, or Foucault does not mean that he musters less useful resources to understand scientific practice. In this section, I will indeed argue that Pepper has unjustly been marginalised and that he provides a unique conceptual toolkit to make sense of science when it is *complicated* – that is, when the definition of science itself is put at stake and when multiple branches of science – e.g., the humanities, social sciences, life sciences, and the natural sciences – come together within a single disciplinary matrix. These conditions are met especially in 'hybrid' disciplines – disciplines that draw on multiple strands and branches of science in order to interpret their object matters. Clearly, Palaeolithic archaeology and the various threads of lithic research it hosts reflect such complicatedness, and may even be regarded as a paradigmatic example of a 'hybrid' field. Having said this, we can start asking for the advantages of using Pepper rather than other available epistemologies of science. Why is Pepper useful in the problem-context at hand?

The first point to be stressed is that Pepper remains one of the rare thinkers, at least to the knowledge of the author, who has seriously considered the totality of Western thought and presented a comprehensive taxonomy to capture it. In contrast to Kuhn (1996 [1972]) and Foucault (1969), for instance, who have come to their respective views on the problem of science and knowledge through an analysis of particular model-sciences – in Kuhn's case physics, in Foucault's case history and the humanities – Pepper's panoply of metatheoretical positions is disciplinarily 'neutral' and consequently avoids the general problems tied to the model-based approach. Pepper explicitly embarks on a maximally broad survey of the dominant tendencies in speculative and metaphysical thought, and to this end examines in particular the history of philosophical questioning. The advantage of this perspective is that philosophical reflection is older than any of the specialised branches of science, and is thus more likely to register and anticipate the full spectrum of human 'world-making' strategies, independently of their disciplinary framing. Moreover, philosophy is traditionally concerned with understanding the world as a whole rather than keeping itself busy with particular problems, themes, objects, or aspects of reality. It can be added that, from a systematic and historical point of view, philosophical reasoning is at the roots of most of the specialised fields of inquiry that we call the 'sciences' today. It is in this sense that Pepper's methodological manoeuvre allows us to take a step back and to search for structures of thought that are pre- and perhaps even trans-disciplinary. Pepper's classification of scientific cognition, as a consequence, promises to transcend well-cemented epistemic boundaries such as the old demarcation between the humanities [*Geisteswissenschaften*] and the natural sciences [*Naturwissenschaften*].[49] By offering such a broad coverage, Pepper avoids self-defeat and questions of scientificity can finally be addressed on comparative grounds, rather than simply reproducing the heralded views of particular fields and research projects.[50]

The second point is a follow-up of the first and has to do with the specific way in which Pepper maps the diversity of credible scientific cognition. The contrast to Kuhn (1996 [1972]) and Foucault (1969), and to a certain extent also to Bachelard (1938), may serve as a foil to clarify this aspect. Both Kuhn, in *The Structure of Scientific Revolutions* (1996 [1972]), and Foucault, in *L'Archéologie du savoir* (1969), put their emphasis on the 'verticality,' that is, the historicity of scientific knowledge developments. Both argue that the diversity of human thought is mainly a product of processes operating on a temporal plane. Kuhn's 'paradigms' and Foucault's notion of « *épistémè* » specify different kinds of historical *a priori*, which are continuously replaced in time.[51] The implication is that there can only be one dominant 'paradigm' and only one dominant 'discursive formation' at any given moment. It is therefore not surprising that many approaches to science that draw on Kuhn or Foucault face difficulties with making sense of intra-scientific fractures and serious intra-disciplinary conflicts. Pepper anticipates this problem and lucidly brings into focus that cognitive diversity is not only a matter of his-

[49] This is at least in part a consequence of Pepper's biography and the people he worked with during his career; it is for instance notable that Pepper interacted quite intensively with seminal psychologists such as Edward Tolman (learning theory, cognitivism) and Kurt Koffka (Gestalt psychology) as well as the influential social theorist Georg Herbert Mead (interactionism, social behaviourism) (cf. Hahn 2000).

[50] This universalist aspiration is only underscored by the central role that Pepper assigns to 'metaphors' and metaphorical reasoning in general (see *infra*); obviously, metaphors have the ability to shape human cognition independently of the specific part of reality or object matter that is investigated.

[51] Foucault (1969) even invokes the idea of *Zeitgeist* ('spirit of an age') to illustrate and support his notion of historically specific 'discursive formations' which replace each other as time goes by.

tory, but also an issue of the 'here and now.' He maps this diversity in its 'horizontality' and acknowledges that different cognitive formations compete for cognitive and social supremacy at any given time. Needless to say, this complies much better with the present project, namely to lay bare the basic sources of conflict which have prompted and solidified the French-Anglophone divide in Palaeolithic archaeology.

The third point is that Pepper's survey of cognition anticipates many, if not most, of the main topics of contemporary philosophy of science and, for that matter, other fields that study science.[52] As the exposition that follows will show, this concerns issues such as: 'theory-laden observation'; the dichotomy of 'facts' and 'values'; the 'prejudice structure' of knowledge formation; the 'disunity' of scientific knowledge; the tension between 'explanatory' and 'interpretive' science, between 'holism' and 'atomism', and between 'reduction' and 'emergence'; the difficulty to make sense of 'part-whole' configurations; the status of 'data,' 'theories,' and scientific 'truth'; the socio-historical framing of knowledge and the role of the individual therein; the 'integration' of disparate knowledge claims; and many more. Some of these issues are explicitly addressed in Pepper's work, while others are only implied or hinted at. The purpose of the present chapter is to reveal this genuine potential and to develop some of it in relation to the problems at hand. It should be uncontroversial to accept that this should help us in clarifying the cognitive stakes of the French-Anglophone divide.

The fourth point is that Pepper helps to retrieve some of the conceptual insights which have largely been lost in the aftermath of the intellectual turmoil of the Second World War. The 'takeover' of Anglophone philosophy by the Logical Positivists and Logical Empiricists and the rise of 'analytic' philosophy in the U.S. and the U.K. only marks the apex of this development. Its consequence was that philosophy itself became a somewhat specialised field of inquiry, characterised by a rather narrow conception of scientificity. This is still the normative dilemma of modern philosophy of science, partly a consequence of the attempt to establish conceptual continuity with the empirical sciences. For Palaeolithic archaeology even worse, its Anglophone practitioners have engaged mainly with the then mainstream 'normative project' in philosophy of science – a project that sought to establish what science *ought* to be rather than how science, as a matter of fact, *is* already practiced and *why*.[53] Pepper can help us to break these bonds and to get rid of the 'prescriptive' baggage of the debate.[54]

The fifth point is that Pepper's exceptionally broad coverage of Western thought can likely contribute to our understanding of the preconditions for the 'underdetermination' of lithic knowledge (cf. Chapter 1). In some ways, this point is certainly a culmination of all other points since an adequate approach to general questions of knowledge underdetermination may have been compromised by overly one-sided understandings of knowledge and science.

As a sixth and last point, it is important to emphasise that Pepper has occasionally been used in other disciplines to examine their respective epistemological structure – for example in psychology (Gillespie 1982; Hayes et al. 1988; Long 1990; Karimi-Aghdam 2016; cf. Goerner 1992; Staddon 1993), biology (Brent 1972), economics (Daly 2000), and systems science (Overton 2007).[55] The results of these studies are generally promising and show the potential of using Pepper for similar purposes. One can add what I have alluded to before: because of the unusual 'hybridity' of Palaeolithic research, it is probable that Pepper is even more fruitful to expose the latter's structure of reasoning. I would argue

[52] This topic is seriously under-researched (but see Reck 1982) – a situation that is perhaps unsurprising given the general neglect of Pepper's contribution at large.

[53] One may indeed argue that this was the critical moment in the history of modern Palaeolithic archaeology after which its Anglophone division in the wake of Binford's *New Archaeology*, Clarke's *Analytical Archaeology*, and Howell's *Paleoanthropology* on the one hand – all modelled on an image of science based on the 'hard' natural sciences – and French 'prehistory' in the wake of Leroi-Gourhan's *« Ethnologie préhistoire »* and Tixier's *« Technologie préhistoire »* on the other – modelled on an image of science based on the 'soft' sciences (humanities, history, interpretive sociology, ethnology, etc.) – became irretrievably disconnected.

[54] The point here is not to say that Anglophone Palaeolithic archaeology is misguided to take up the conception of science favoured by the 'normative project'; the point, again, is merely to emphasise that this already implies a very specific stance to science, a form of perspective-taking that is a part of the difficulty to navigate the French-Anglophone divide. To clear the view for the actual stakes of the divide, we must therefore also clear the view for the full spectrum of conceptions of science that can be seriously considered.

[55] See also Stroud (2015) for an engagement with Pepper in terms of the 'rhetorics of criticism' in science and aesthetics.

that the results obtained by the present investigation support this claim (see Chapter 6), but I leave it to the readers to be the judge of this.[56]

2.2 The landscape of Western thought

In *World Hypotheses* (1942), Stephen Pepper argues that the diversity of credible trajectories of Western thought can be comprehensively captured by four distinct ways of making sense of the world, all of which are relatively adequate in their own right (*ibid.*: 1).[57] These 'world hypotheses' are surprisingly 'empirical' according to Pepper and have developed out of ordinary or common-sense experience (cf. Pepper 1967: 1). As world hypotheses, they have been constantly refined and expanded over the course of the centuries and are, in their core, at least as old as philosophical speculation itself. World hypotheses represent hypotheses about the world and are as such distinguished by their *unrestrictedness* – they contain statements about the structure of the world as a whole and help to organise the totality of the available and possible evidence (Pepper 1942: 78, 1943: 602);[58] their peculiarity, moreover, lies in the fact that no world hypotheses can be rejected as completely irrelevant (*ibid.*: 1). We can thus say that world hypotheses encapsulate the pillars of refined cognition.

World Hypotheses originally identified and discussed six of such world hypotheses, from which, however, only four were diagnosed to have withstood the scrutiny of history – with 'animism' and 'mysticism' failing the test of time. The remaining four – 'formism,' 'mechanism,' 'contextualism,' and 'organicism' – are considered the only world hypotheses to have shown great *cognitive adequacy* (Pepper 1935a: 370, 1942: 141-150). This cognitive adequacy, according to Pepper (1936: 576), renders them the best tools we currently possess to transform uncriticised 'common sense'[59] into 'refined knowledge' – into what Pepper (1942: 39-70) broadly identifies as scientific knowledge.[60] Yet, all of the four world hypotheses have their respective problems and are far from ideal in making sense of the world – *none* of them is fully or perfectly adequate and all of them seem to truncate and/or marginalise some critical aspects of the world (cf. Pepper 1935a: 370, 1942: Chapter VI; these relative weaknesses of each of the four adequate world theories are exposed in some detail in **Appendix II**).

Although a world hypothesis is constantly corroborated and tested by the evidence it makes available (Pepper 1967: 5; cf. Monast 1975: 95f.), its unrestricted nature concurrently renders it a necessary precondition for marshalling evidence, formulating theories, and identifying or discussing problems that arise during the research process. A world hypothesis in Peppers sense is therefore something that *must* be formulated or accepted – at least tacitly –before any serious scientific inquiry can start.[61] Even though world hypotheses themselves, as hypotheses, are empirical entities and as such maintain links to common-sense experience throughout their use-life, they are hence also 'pre-empirical' insofar as they help to structure how evidence is gathered, analysed, and finally interpreted; they constitute elementary cognitive devices to orient any examination of fact.[62] To this effect, a world hypothesis delineates a wider cognitive system that includes basic statements on how the world is hold together and thereby makes possible to systematically access this world (cf. Pepper 1942: 74). A world

---

[56] This is Lakatos' argument of 'eating the cake.' The argument holds that in order to judge how well a cake is made, one needs to eat it. By analogy, theoretical claims or frameworks literally have to be "eaten" first before their fecundity can be evaluated – "eaten" in the context of theories usually means "applied" or "executed."

[57] In a later book, *Concept and Quality* (1967), Pepper sought to establish a fifth relatively adequate world hypothesis – 'selectivism.' Due to its unclear and somewhat controversial status, I will, however, limit my investigation to Pepper's original four world hypotheses here (see **Box 4**).

[58] More specifically, this means negatively that a world hypothesis rejects no evidence from its field and positively that it seeks to organise the totality of evidence (Pepper 1943: 602).

[59] What Pepper names 'common sense' has also been termed 'opinion,' 'middle-sized fact,' 'pre-analytical fact,' or 'folk-psychological view' to name but a few (cf. Pepper 1935a).

[60] Pepper (1942) is of course more rigorous in his account but because his differentiations do not matter much for the present purpose, I will not linger on them for any longer. It should be mentioned, however, that he refers to the realm of common sense in which uncriticised facts or evidence in the form of 'dubitanda' are found as the 'roots of knowledge,' whereas criticised facts come in the form either of 'data' or 'danda' and are referred to as the 'fruits of knowledge' (cf. *ibid.*: 68).

[61] This, of course, does not mean that each scholar has to consciously formulate such a world theory before she/he can begin her/his localised inquiry. Most of the time, world theories are only loosely attached to individuals and their role is "passive" rather than "active" (see *infra*). This also means that they are rarely made explicit during the research process although they can be shown to substantially guide it. I will return to this point in Chapter 6.

[62] Pepper (1942: 72-74) tries to capture this 'structuring' effect of world hypotheses by their capacity to "cognitively prescribe," an ability that common-sense experience lacks. This ability to structurally *prescribe* is not to be confused with the ability to predict – a specific instance of the prescriptive aptitude proper to the world theory of 'mechanism.'

hypothesis understood in this way constitutes a somewhat 'passive' yet all-encompassing theory – a 'world theory' – which can be distinguished from the more 'active' local theories that are explicitly developed, discussed, and negotiated in practiced science but remain constrained and bounded in their application (Pepper 1935b: 16; cf. Monast 1965: 98).

Each world hypothesis is quite specific about the type and nature of the evidence it typically carves out (cf. Pepper 1942: 68). This means that the specification of observations that can serve as *data* is part of the work that a world hypothesis does (Pepper 1935a: 371, 1942: 51f., 68). Consequently, different world hypotheses tend to marshal different types of evidence, or at least evidence that is not directly comparable (cf. Monast 1975: 132).[63] This clearly constitutes one of the key sources of the cognitive autonomy of world theories. Each world hypothesis generally differs in how it handles and 'digests' common-sense experience – a situation which, in turn, results in basic disparities in how the world is partitioned, what is brought into focus, and what is downplayed or even whitewashed. As Pepper (1935a: 369) puts it, world hypotheses therefore emerge as "our ultimate source for the discovery of the nature of facts."[64]

In providing such general cognitive orientation, world hypotheses inevitably entail value judgements and favour their own view(s) of science – views that seek compatibility with the heralded values.[65] This is the unescapable normativity of world hypotheses (cf. Efron 1980: 20).[66] World hypotheses constitute relatively enclosed cognitive systems, in which understandings of the world, types of evidence, values, methods, theories, arguments, and interpretations are circularly coupled. They are constantly adapting to each other in order to render the world theory internally coherent. As a result, the conceptual framing provided by different world hypotheses will typically support unequal interpretations of all of the respective dimensions of research (cf. Pepper 1935a: 367, 1942: 79f., 1967: 5).[67] In general terms, this situation should be familiar to students of philosophy of science and may count as an early formulation of the inevitable *value-* and *theory-ladenness* of all scientific endeavours, later popularised by Kuhn (1977) and his followers.[68] The ingenuity of Pepper's *World Hypotheses* lies in the fact that it elegantly anticipates the Kuhnian idea of 'theory-laden observation'[69] and combines it with the core insight of hermeneutic thinking – that is, the empirically grounded *prejudice structure* of all knowledge formation – which was later systematised by Gadamer (1960) and others.[70] In doing so, world hypotheses arise as indispensable, highly effective, yet extremely dynamic catalysts of human reasoning in general.

Having said this, it is important to recognise that each wider cognitive system centred on a world hypothesis can easily integrate multiple 'localised' theoretical and epistemological positions while not being reducible to them; this is because world hypotheses signify *meta-theoretical standpoints* that group epistemic and, by extension, scientific stances on a higher level. For instance, 'materialism' and 'realism' tend to be associated with 'formism,' whereas 'naturalism,' 'behaviourism,' and 'adaptationism' generally gravitate towards 'mechanism.' Similarly, 'interactionism,' 'social constructionism,' and 'pragmatism' tend to be associated with 'contextualism,' while 'structuralism' and many holistic evolutionary theories strongly gravitate towards 'organicism.' Already this brief sampler makes immediately clear why Pepper's framework is so useful for the purpose at hand: it promises to estab-

[63] This may or may not include different ways of transferring evidence into analysable data.
[64] For Pepper (1942: 79), evidence and interpretation are thus inescapably merged in a world hypothesis: "[i]n a world theory it is impossible to say where pure fact ends and interpretation in fact begins. Within the theory itself the distinction is clear. The theory will tell you what a fact 'is' and what in fact is theory. But another equally reliable theory will draw the line in another place" (cf. also Pepper 1943: 602).
[65] This is another reason why the normative quest for the one adequate 'method of science' – if the hypothesis of world hypotheses is correct – appears to be deeply misguided. What science *is* or *ought to be* can only be answered relative to already accepted world hypotheses and can hence only be objectively determined in relation to the standards established by their cognitive framing.
[66] This is effectively a rejection of the fact-value dichotomy for the separation between 'facts' and 'values' is pointless within world hypotheses.
[67] For a detailed exposition of the prominent although not always immediately evident role of *value* in Pepper's work, see Efron (1980: 20).
[68] For a recent sampler of key discussions on the role of values in science, see Schurz and Carrier (2013).
[69] There is in fact reasonable ground to suspect a certain influence of Pepper on Kuhn's formulation of the concept of the 'paradigm' (cf. Efron 1980: 23).
[70] Gadamer's (1960) original German concept for this is *Vorurteilsstruktur des Wissens*.

lish a simple taxonomy of epistemic positions without getting lost in the intricacies and details of particular theoretical stances – details that may be unimportant for comprehending the bigger picture.[71]

2.3 **Root metaphor theory**

The core of each world hypothesis is constituted by what Pepper calls 'root metaphor.' A root metaphor is both the core and origin of a world hypothesis (cf. Pepper 1935a: 365). To identify and analyse root metaphors enables a general understanding of how different world hypotheses operate. In general terms, root metaphors specify the core intuitions and features found in common-sense experience, around which a world hypotheses is built (Pepper 1942: 91f.). Root metaphors are the primary devices which carry over these core intuitions and basic insights in order to systematise and develop them, so that the world can be described, interpreted, and criticised in relatively reliable and adequate ways. This interrelationship between a world hypothesis and its root metaphor is what Pepper tries to encapsulate in his 'root metaphor theory' (cf. Pepper 1928, 1935a: 369). The theory entails a number of theorems ('maxims') which inform about the nature of world hypotheses and prepare the ground for analysing them – an analysis that Pepper (1942: 91-96) aptly terms 'root metaphor method.'

Pepper's root metaphor theory generally responds to the simple question of 'how a world hypothesis is constructed in the first place.' This question can easily be reformulated so that it transforms into a historical question – in Pepper's terms, we can ask: "how does a world hypothesis arise?" (Pepper 1935a: 369). While root metaphor theory tries to advance analytical and systematic statements about the status and functioning of varying world hypotheses, it thus also places emphasis on their *historical development*. This last point cannot be overemphasised since it allows us to grasp how world hypotheses may alter over time and is generally consistent with the recurrent emphasis on the 'historicity' of science and its ever-transforming character that pervades science studies at large.[72]

As the historical and conceptual origin of world hypotheses, root metaphors specify the conditions under which 'uncriticised' knowledge is transferred into 'scrutinised' and 'criticisable' scientific knowledge. In contrast to world hypotheses themselves, which by definition are 'global' in scope, root metaphors always have a 'local' origin (cf. Pepper 1967: 3). They are propelled by strong common-sense intuitions[73] which derive from *specific domains of observation* or *selected groups of facts*.[74] These are then 'cognitively digested' by reference to the root metaphor as Pepper (1935a: 369) calls it – they are systematised and refined so that their analysis enables their *expansion* to other domains or parts of observation in order to elucidate them (*idem*).[75] It is this capacity of a root metaphor to pro-

---

[71] What I try to investigate in the present study is whether and to what degree this seems to be the case. A brief survey of the available theoretical literature suggests that previous attempts to structure the landscape of archaeological thought have often led to unnecessary confusion by going astray in a multitude of 'isms' – 'isms' whose cognitive significance and heuristic power cannot be taken for granted and has rarely been demonstrated.

[72] This indicates that Pepper already recognised that science cannot escape its historicity, even though his conception of history stresses multi-linearity rather than uni-directionality and recasts scientific progress as a complicated and not always transparent process (see *infra*).

[73] The concept of 'intuition,' although not spelled-out in detail, is central to Pepper's theory of knowledge. Intuitions in Pepper's sense are assessments of the structure of reality with unparalleled immediacy; intuitions are produced in direct interaction with the parts of the world and hence derive from formative common-sense experiences and other observations that are deemed key to understand the nature of reality. They are not infallible, however, and not every intuition is as good as any other. Even though epistemic intuitions form the necessary starting point of developing a world theory, they always have to *prove* their fruitfulness while they are systematised and refined scientifically. Pepper's notion of 'intuition' comes perhaps closest to what Gopnik and Schwitzgebel (1998) refer to as the interpretation of *intuitions as hypotheses*; accordingly, intuitive judgements are simply "particularly plausible hypotheses about the nature of the world" (*ibid.*: 78). The difference to non-intuitive judgements – the kinds of judgement science naturally aspires to – is simply that intuitive judgement is not based on some kind of explicit reasoning process which the person who makes the judgement can consciously observe (*ibid.*: 77). Rendering judgment-making "observable" in this sense marks the crucial transition to scientific cognition. At any rate, appeals to 'epistemic intuitions' are clearly not obscure and still permeate modern epistemological theorising. Epistemic intuitions for instance still serve to evaluate whether claims fall on one or another side of some significant divide in epistemology (cf. Nagel 2007). In psychology, intuitive cognition is now widely recognised as a foundational element of all human reasoning and decision-making (Kahneman and Tversky 1996; Gigerenzer 2007). The important point about intuitions in science, however, seems to be that the latter, through its reflexive attitude, tends to cultivate specific intuitive predispositions and to hide them in seemingly hyper-conscious processes of reasoning.

[74] Cf. "[…] [P]erhaps the only way, in which metaphysical hypotheses [world hypotheses] can be derived is through the analysis of a selected group of facts (which I call the root metaphor) and the expansion of that analysis among other facts." (Pepper 1935a: 365)

[75] Pepper closely converges with Nelson Goodman's (1966) account of *reflective equilibria*. According to this idea, cognitive progress is made primarily by adjusting our local and more general theories to better match with our case-bound intuitions while also adjusting these intuitive judgements to better conform to our theories – this is what Goodman (*ibid.*: 66) refers to as

cess a local but persuasive common-sense understanding in such a way that reality as a whole can be grasped that renders it constitutive for its world hypothesis. Root metaphors, in other words, are metaphors that can be intuited in the 'local' and based on what they thereby encapsulate furnish an effective canon of conceptual resources to interpret the 'globality' of fact which they gradually encounter during their expansion.[76] Eventually, it is this friction between the global aspiration of a world hypothesis and its local origin that helps to explain a world hypothesis' partial yet unavoidable inadequacy – domain-specific intuitions have to be 'stretched' and thereby to be altered in order to accommodate the totality and richness of reality as a whole.[77]

Additionally, the constitutive tension between the 'local' and the 'global' elucidates why each world hypothesis maintains some traces of *dogmatism* (cf. Pepper 1935a: 372, 1942: 115-120). The initial set of 'facts' and common-sense experiences that define any world hypothesis' point of departure, although of course being amendable to cognitive refinement during the development of the hypothesis, are largely withdrawn from systematic scrutiny and are hence usually assumed to be 'self-evident' and/or 'indubitable' (Pepper 1935a: 369).[78] It follows that the core 'facts' and intuited key categories of a world hypothesis are largely *immune to revision* (cf. *ibid.*: 366)[79] – the hypothesis would in fact collapse if they would be abandoned and/or substantially revised. A certain degree of dogmatic security is therefore a necessary ingredient of any world hypothesis. This leads us to a somewhat paradoxical situation since dogmatism, in general, appears to be detrimental to cognitive advancement because it terminates debate and critical refinement (cf. Pepper 1942: Chapter II); yet, a residual 'dogmatic core,' as we have seen, is nonetheless required for making credible sense of the world as a whole; dogmatism thus seems to inhibit and enable insight at the same time – a curious feature of Pepper's world hypotheses theory to which I will return again to at the end of this chapter.

How do root metaphors give birth to their world hypothesis? The principal mechanism to do so is 'metaphorical conjecture.' The concept enables a basic understanding of how metaphors help to mediate the expansion of analysed facts, concepts, and categories from the context of their initial discovery to other 'foreign' contexts. What has been learned from the initial domain of observation and its hypothetical explanation can in this manner be transposed and/or extrapolated into a new domain of observation, which in turn can be re-interpreted through the lenses of the mediating root metaphor, and so forth until unrestricted scope and great adequacy is reached – it is in this sense that metaphors use one part of experience to illuminate another (cf. Efron 1980: 22). 'Metaphorical conjectures' thereby trigger a recurrent systematisation and cognitive codification of the original metaphor by testing its performance and monitoring its internal consistency in the face of hitherto un-encountered facts – the ultimate result of which is the formulation of an unrestricted hypotheses and its development (Pepper 1942: 328). 'Cognitive refinement' is nothing else than the process of gradually enhancing the capacity of a root metaphor to corroborate the evidence it generates during such an expansion (*ibid.*: 75). We may hence speak of a 'root metaphor' when the hypothetical systematisation of a locally retrieved metaphor has resulted in a field of application that is identical with the world as a whole.

How and to what effect such a root metaphor can be 'enhanced' relies entirely on the metaphor itself – on its *metaphorical* and *associative space* and the general proficiency of this space to devise concepts and categories that are able to secure and to improve the cognitive adequacy of its world hypothesis – root metaphors are hence primarily developed internally. The relative strength of a root

---

the 'dual adjustment between definition and usage' so that the usage informs the definition and the definition guides future usages and/or the expansion of usage.

[76] In Pepper's (1935a: 369) own terms, this can be understood in the following way: "[The selected facts] are cognitively digested and analyzed. Their structure is usually found capable of rather wide extension through uncriticized facts not at first supposed to be of their nature. This structure is then elevated into an hypothesis for the explanation of other uncriticised facts, as a result of which these become critically interpreted in terms of the root metaphor. In the course of this interpretation, the root metaphor itself may undergo critical analysis and refinement which reciprocally increases its range and power of interpretation. When it assumes unlimited range, or world-wide scope, then it is a metaphysical hypothesis, and a catalogue of its principal descriptive concepts is a set of metaphysical categories."

[77] Needless to say, it is likely that something of importance is lost in this process – it is in fact likely that the core intuitions witness a gradual 'alienation' and thereby lose part of their initial cognitive appeal.

[78] It follows that concepts such as 'undeniable intuition,' 'self-evident,' 'indubitable,' and even 'observation' always represent *internal categories* of a given world hypothesis – they form, in other words, all *part* of the cognitive canon that a world hypothesis delineates (cf. Pepper 1935a: 366). Consequently, they cannot be criticised by the cognitive standards effectuated by other world hypotheses – an issue that has important consequences for how world hypotheses may interact (see Chapter 6). Some of these considerations anticipate the insights of Quine (1951a) and Wittgenstein (1958), making a huge splash in philosophy of science after their dissemination.

[79] Cf. "The symptom of dogmatism is the refusal to permit certain materials to be doubted." (Pepper 1935: 366)

metaphor lies in its ability to make successful 'metaphorical leaps' – that is, to adapt its conceptual repertoire to conflicting or hitherto undiscovered facts – for instance to a newly discovered domain of reality – in such a way that the mobilised world hypothesis remains intact and is further corroborated.[80] To make a 'metaphorical leap' hence simply means to re-interpret available facts in light of the utilised root metaphor so that the overall degree of structural corroboration provided by the metaphor's world hypothesis is increased. It is in this sense that we can hold that both the 'shape' and 'boundary' of each cognitive landscape surrounding a world hypothesis fundamentally depend on metaphorical insight (cf. Mattice 2014: ix).[81]

> "In developing a world hypothesis, the cognitive appeal must accordingly be always to the evidence available, and none of this evidence should be offered as certain. There will in this way develop a give and take between the evidence and the categories of the hypothesis ordering the evidence. The more the evidence corroborates the hypothesis the more it also corroborates itself in the interpretation it receives through the hypothesis. The root metaphor method is the regular empirical method of hypothesis supported by the evidence to the degree that the evidence corroborates the hypothesis and renders it relatively adequate. A world hypothesis, as we said earlier, differs from other empirical hypothesis only in its characteristic of being unrestricted in its subject matter." (Pepper 1966: 5)

Pepper's own stance towards metaphor is rather pragmatic; in his early work he already states: "[i]t is pedantic to object to metaphor. Every philosophical theory is a far-flung metaphor" (Pepper 1928: 130). For Pepper, this role of metaphor to cognitively 'guide' and 'give shape' is not limited to philosophical speculation but also holds true for scientific reasoning. Science is to a large degree understood as a process of bringing metaphors to bear, to refine and systematise them, and to recursively test their epistemic value. This, however, does not imply that Pepper reduces science to a mere 'language game' or defines it primarily as a linguistic phenomenon; to the contrary, he argues that metaphors, because they are initially found in intuition and therefore take stock of concrete experience, are able to bridge the 'abstract terms' on which science relies and the 'concrete objects' which it studies – metaphor, according to Pepper (*ibid*:: 131), can hence be recognised as a basic means to deflect thorny mind-matter issues. With Pepper we can say that metaphors help to 'dapple' the world (cf. Teller 2004), but they do not help to construct it; the status of metaphors is thus intermediate: they regulate the *contact* between the world and any hypotheses put forth to capture the world.[82] This conception is generally consistent with semantic field theories which hold that metaphors greatly facilitate and channel 'epistemic access' by utilising a set of given ties to form a new set of ties or extend already given sets (e.g., Feder Kittay 1987).[83] Metaphors thereby establish the 'rules of interaction' between cognition and world. This modulating role of metaphorical reasoning is generally difficult, if not impossible, to question (see e.g., Lakoff and Johnson 1980a, 1980b).[84]

It is through this 'guided' interaction between the world and the hypothesis put forth to make sense of it that root metaphors furnish a specific set of *structural categories* – structural categories which define the nature of the world hypothesis they anchor.[85] They are nothing else than the product

---

[80] Naturally, there is no criterion available to decide *a priori* which root metaphors are more likely to be 'successful' in this regard. A root metaphor can only be shown to be relatively adequate to deal with the totality of its evidence, by means of its own *creative potential* – which, again, can only be discovered in the process of its refinement. There is also no guarantee that the most promising root metaphors have already been found, since the relative effectiveness of a given root metaphor also depends on how it is cognitively harnessed by particular people. It is therefore generally possible that the cognitive value of some basic metaphors has not been recognised yet.

[81] For the general importance of metaphor for philosophical and, by extension, scientific thought, see also Mattice (2014: Chapter 1).

[82] It needs to be said here that the reliance of a cognitive system on a single root metaphor does of course not preclude that other metaphors also play a role in digesting the evidence; yet, these metaphors must be 'derived' metaphors insofar as they are interpretable through the root metaphor and can be placed without any problems in the 'semantic field' of the original root metaphor – we then can say that it is the root metaphor which links and/or holds together distinct fields of metaphorical significance brought into existence by its 'derived' metaphors. There is thus room for a hierarchy of metaphors but metaphors which are not interpretable through the root metaphor inevitably introduce an 'eclecticistic' element to the world theory in question.

[83] Similar positions have also been developed in (meta-)archaeological theory. Especially the idea that archaeological practice and theory are driven to a large extent by metaphorical reasoning and conjecture is not new at all (cf. Shanks 1992). It is interesting to note in this context that in *Experiencing the Past*, Michael Shanks (1992: 42, 50, 166) explicitly utilises the same term – "root metaphor" – to describe different modes of archaeological engagement with the past.

[84] The role of metaphor was of course also recognised and theorised in cognitive linguistics, where, incentivised by the 'linguistic turn' which gained moment from about the 1960s onwards (cf. Rorty 1967), metaphor became widely viewed as a key mechanism for grounding cognitive systems and domains and to enable the transition between them.

[85] In the context of world hypotheses only *structural corroboration* is thus possible. Note that this insight anticipates key arguments of Quine's seminal *Two Dogmas of Empiricism* (1951a), in which the latter criticised the dominant 'analytic' dogma of his

of analysing, systematising, and refining a root metaphor in the course of its expansion. These 'structural categories' consequently specify how a world hypothesis orders and corroborates its evidence (cf. Pepper 1942: 329). Sweeping differences between world theories can therefore profitably be understood as disparities in the sets of 'structural categories' they mobilise. We can even say that each canon of 'structural categories' is only intelligible – in terms of its overall functioning and the interplay of individual categories – if interpreted through the lens of its original root metaphor. This brings us back to the starting point of this section and helps to clarify why an analysis of world hypotheses must be based on the careful exposition of root metaphors and why one cannot look at the categories in isolation.

Having said all of this, it remains important to stress that Pepper's root metaphor theory – even though it relies on 'metaphorical conjecture' – offers a clear rejection of the arbitrariness of root metaphors and their corresponding world hypotheses (cf. Efron 1980: 22). While Pepper gladly admits that metaphorical reasoning affords a great deal of intellectual freedom, root metaphors are always judged by their relative cognitive appeal and thus by the cognitive adequacy they can legislate about; this, in turn, is not simply a matter of convention but rather a question of interacting with the world and reaching high degrees of 'structural corroboration' as a result. Which metaphors are capable to provide the conceptual resources to achieve this is an open question and can only be answered empirically. The theory therefore resists falling prey to 'relativism' since the *selection* of potent – or 'pregnant' (Pepper 1935a: 132) – metaphors is key and not every metaphor is as good as any other. Pepper's key manoeuvre is his insistence on selective historical forces to reveal the relative success of different metaphors in refining themselves and corroborating the world hypothesis they embody. This historical conversion of a local hypothesis into a unrestricted hypothesis of world-wide scope always effectuates a test for the ability of the underlying root metaphor to work towards increasing cognitive adequacy – even if this cognitive adequacy can only be evaluated comparatively and thus always remains 'relative' in nature (cf. Pepper 1942: 120).

From the perspective of root metaphor theory, the history of Western intellectual thought can then be understood as a history of developing the relatively successful and promising metaphors – largely unsuccessful metaphors, by contrast, are typically discarded in the process but may re-appear from time to time to be tested again.[86] If we seek to understand the general structure of scholarly cognition we are thus well served with concentrating on the few root metaphors that have demonstrated this former capacity (Pepper 1942: 331, 340). This deflects the spectre of 'relativism' – two additional criteria must be satisfied when metaphors and the world meet: the motivated hypothesis must possess (a) the *scope* to capture the world as a whole (unrestrictedness) and it must maintain (b) a high degree of *adequacy* ('structural corroboration') (cf. Pepper 1935a: 370).[87]

According to Pepper (1942: 96-114), all of these considerations allow us to identify four maxims that regulate the development and cognitive refinement of world hypotheses – maxims that therefore capture the basic claims of Pepper's root metaphor theory: (i) *a world hypothesis is determined by its root metaphor*; (ii) *each world hypothesis is autonomous*; (iii) *eclecticism is confusing*; and (iv) *concepts which have lost contact with their root metaphors are empty abstractions*. Maxims (iii) and (iv) are particularly important since they represent a plea for 'purity' of metaphor (cf. Pepper 1942: 98, 104, 330). For Pepper (1928: 131f.), conceptual clarity is often obscured by the use of 'mixed metaphors.'[88] The reason is of course that they tend to undermine a world theory's internal consistency and may easily motivate conflicting readings of the same fact (Pepper 1935a: 373). What is perhaps more dangerous, however, is that a mixing of metaphor typically distorts and/or dilates its reliable corrobo-

---

time that synthetic sentences can always be tested empirically in isolation. In fact, what is today known as 'Duhem-Quine-Thesis' forcefully maintains that individual sentences (or any other 'atomistic' bearers of knowledge) can never be tested *eo ipso*, but only as parts of larger 'webs of meaning,' e.g., of 'theories' and the like.

[86] For Pepper (1946: 604), some of these patterns of resurge can be explained by historically and socioculturally specific cognitive interests: "[c]ultural interests, I believe, account for the emphasis placed upon certain types of thinking at certain times, and for the kinds of eclecticism most appealing at certain times, and even perhaps for the emergence of certain root metaphors at certain times, but I cannot see how they have anything to do with the corroborative powers of certain types of thought."

[87] Pepper (1928) maintains already from early on that "[…] making the best of metaphors means selecting the most pregnant, that is to say, those that will stretch over the widest range of experience with the least amount of straining."

[88] Pepper (1942: 330) explicitly opts for "rational clarity in theory and reasonable eclecticism' in practice" and characterises the dangers of 'eclecticism' as follows: "That an eclecticism should be excluded from within world theories is obvious in the interests of clarity; otherwise, how can one see just where the maximum of structural corroboration lies? If a world theory partly developed in one set of categories is broken in upon by a foreign set of categories, the structure of corroboration is broken up and we cannot see clearly how the evidence lies. For intellectual clarity, therefore, we want our world theories pure and not eclectic."

ration (cf. Pepper 1942: 341); 'eclectic' theories have therefore typically difficulties with upholding the degree of cognitive adequacy required. Maxim (ii) is, if you will, a consequence of this general difficulty to combine root metaphors. It not only explains why world hypotheses tend to be vastly different, but also provides an argument for why world hypotheses cannot be reduced to one another (cf. *ibid.*: 341); doing so would require to interpret one root metaphor in light of another, which would completely collapse the former's world hypothesis and thereby eliminate all of its specifics, including its unique cognitive capacity (*ibid.*: 106).

The interplay of all of the five maxims, finally, is capable of explaining, first of all, why systematic and relatively adequate attempts to make sense of the world necessarily cluster into several *distinct groups* – i.e. 'schools of thought' – and why, secondly, there are only a *limited number* of such groups (Pepper 1942: 340f.).[89] The significance of this assessment lies in the acceptance of the necessary horizontal diversity of all human inquiry based on strictly alternative world theories and the simultaneous repudiation of the idea that this diversity is without any shackles (cf. Pepper 1935a: 370). Because scientific reasoning is merely a special variant of human inquiry, it follows that science is generally subjected to the same constraints. Thus, scientific reasoning also clusters into irreducible and fully autonomous families of 'world-making,' anchored in distinct root metaphors and leading to alternative interpretations of the facts discovered.

To conclude, Pepper's root metaphor theory rests on rather uncontroversial premises – namely, that metaphor shapes scientific thought and thereby influences how we make sense of the world – but draws some intriguing conclusions for what this means for the overall structure and progression of scientific thought – implications which have, as I aim to show in this dissertation, important consequences for how one can hope to navigate difficulties that arise when vastly different approaches to science clash in practice. Pepper's root metaphor theory also provides some interesting and hitherto largely untapped opportunities to explore the interrelationship of the historical development of scientific projects on the one hand and the general character of their social and cognitive landscapes on the other. Central to the present purpose, however, is a closer understanding of the general structure of Western thought and the most potent root metaphors that have been developed and refined in the course of its history. The following section gives a general overview of this structure and elaborates the 'structural categories' of the four relatively adequate theories which have been identified up to now.

2.4 **Four distinct ways of marshalling evidence**

2.4.1 ***The general structure of world hypotheses***

The two general cognitive criteria to establish the significance of world hypotheses – what Pepper (1935a: 368) has called the "factuality of fact" or the "truth of hypothesis" – are *scope* and *adequacy*. Both criteria mutually support each other; they are both necessary conditions for a world hypothesis but become sufficient only in pair.

'Adequacy' explicates the power of the hypothesis to provide satisfactory descriptions of matching facts or groupings thereof. Following the maxim of autonomy, what such 'fitting' accounts for and which 'mode of fitting' is looked for is, as Pepper says (*idem*), "at the discretion" of each world hypothesis and therefore part of the assertive claim of the hypothesis itself – nonetheless, the 'fit' must obviously be a 'good fit'. For this reason alone, each world hypothesis brings forth distinct standards of knowledge evaluation, distinct methods of knowledge corroboration and therefore establishes distinct truth conditions – each theory, in other words, favours its own 'theory of cognitive criticism' (cf. Pepper 1942: 150).

'Scope' explicates the *range* of consistent descriptions that the hypothesis is able to provide. In fact, "[t]he greater the range of consistent descriptions the greater the assurance as to the adequacy of

[89] For Pepper (1942: 328), root metaphor theory is therefore also a tool to *reduce* the number of credible world hypotheses by means of unearthing their standards of cognition and knowledge formation. He (*idem*) explicitly declares: "The root metaphor theory is simply the recognition of the fact that there are schools of philosophy, and an attempt to get at the roots of these schools. We argued that the philosophic imagination is not nearly as prolific as many have believed. We showed grounds for believing that there are only seven or eight distinct ways in which men have seriously undertaken to build up unrestricted hypotheses. The appearance of a great number of different world theories arises simply from the great number of combinations that can be made out of the parts of seven or eight complex objects – the world hypotheses we have discussed."

any given description" (Pepper 1935a: 368). 'Scope' thereby also theorises whether all available and recognised 'facts' are taken *positively* and are used to support knowledge claims or whether they are instead 'explained away.'[90] For world hypotheses are unrestricted hypotheses, Pepper maintains that no fact can be ignored by them (*idem*) – world hypotheses can maintain their all-encompassing status only if they include the entirety of available evidence into their field and seek to organise it (cf. Pepper 1943: 602). Explaining away must therefore be understood as part of the substantial *explanatory work* that a world hypothesis does – it is part of the hypothesis' ability to specify what is relevant in the world and what is not.[91]

This capacity of world hypotheses to handle facts *negatively* leads to a situation in which 'scope' often turns out to be inversely related to 'precision.' Optimising the 'precision' of a hypothesis, that is, amplifying the resolution of the factual interlinkages and the discriminability of facts (cf. Pepper 1942: 76), typically requires to explain away a lot – the chief example being 'mechanistic' explanations which only encompass those facts which are considered to be causally related. This enters into a state of affairs in which cognitive resources can either be invested to develop the 'scope' of a hypothesis or its 'precision' (cf. *idem*) – al-though developing either tends to enhance a hypothesis' capacity to also refine the other (*ibid.* 76f.).[92]

As mentioned earlier, Pepper (1942: 141, 151-314) recognises four relatively adequate world hypotheses: 'formism,' 'mechanism,' 'contextualism,' and 'organicism.' These theories are labelled rather unusually compared to the classic metaphysical positions or 'schools of thought' in order to avoid confusion, but the residual terminological affinities are deliberate and yield some wider significance. As detailed before, each of these four world hypotheses is firmly grounded in its respective root metaphor and is able to gather multiple theoretical positions under its banner. Since the structural organisation of world hypotheses ushers a higher-level taxonomy to talk about differences in scientific 'world-making,' no simple or one-to-one correlation between the classic positions and world hypotheses is possible.[93] World hypotheses are foremost historical entities and their links, if any, to the theoretical or social entities of the science of a given timeframe must be demonstrated rather than presumed.

The four relatively adequate world hypotheses organise themselves into two groups of two each (Pepper 1942: 141-150; **Fig. 1**). The first distinction is to be drawn between 'analytic' and 'synthetic' world theories.[94] This is not to say that the former group does not acknowledge *synthesis* and the latter *analysis*, but merely points to the fact that 'synthesis' and 'analysis' have a different status in two groups (cf. Pepper 1942: 142). While the first group presumes that particulars are basic and that the given 'facts' primarily consist of 'elements' or 'factors,' the second group only acknowledges the basic factuality of 'complexes,' 'contexts,' and/or 'structures' and therefore presupposes the primacy of wholes. For the 'analytic' world hypotheses, therefore, parts are basic and wholes are derived; for the 'synthetic' world hypotheses, to the contrary, wholes are basic and parts are derived (*idem.*). This reverted organisational logic leads to the identification of 'formism' and 'mechanism' as 'analytic' world theories and of 'contextualism' and 'organicism' as 'synthetic' world theories (cf. *ibid.*: 146). The former set of two is predisposed to adopt variants of 'methodological individualism,' whereas the latter gravitates towards 'methodological holism' when analysing its evidence (see **Box 5**).

---

[90] In general, to increase the 'scope' of a hypothesis of course means to find more 'corroborative facts' for it – that is, to increase the number of facts that support its claims (Pepper 1942: 76).
[91] In practice, of course, there is often no difference between specifying what is of relevance and specifying what is 'real' and what is 'unreal' (cf. Pepper 1942: 143f.).
[92] This outcome, however, is surely not guaranteed since the enrichment of either of the two may have some constraining effects on the other as we have seen – how 'scope' and 'precision' interact within a given world theory is fore and foremost a question of empirical examination and may well differ from research context to research context.
[93] This is one of the main advantages of using world hypotheses theory to understand the structure of particular sciences. World hypotheses-based taxonomy allows for a rough reorganisation of perspectives and approaches with a focus on root metaphor rather than theoretical contents, contents which are often opaque and difficult to evaluate with respect to their ability to determine how evidence is marshalled and interpreted.
[94] The distinction between 'analytic' and 'synthetic' is one of the recurrent spectres of contemporary philosophy. The distinction dates back at least to Immanuel Kant and haunts human inquiry in the West since then. Pepper's point, however, is not to insist on the soundness of the distinction, but rather to show that it provides such a powerful heuristic that major threads in Western thinking can be profitably reconstructed based on it. The perspective taken is thus pragmatic and the surge of criticism on the validity of the distinction that has emerged in the later part of the 20th century must not bother us much. In fact, the conceptual weaknesses and inconsistencies of the four relatively adequate world theories can be interpreted as difficulties to convincingly navigate the 'analytic'-'synthetic' divide (compare **Appendix II;** for some of the historical reasons for this decomposition of the Kantian architectonic in an 'analytic' and a 'synthetic' strand, see Friedman 2000: 145-159).

The second disparity in world hypotheses is between what Pepper (1942: 142) has baptised 'dispersive' and 'integrative' theories. Here, the polarity can be found between the members of each group. 'Formism' and 'contextualism' are 'dispersive' world theories and 'mechanism' and 'organicism' represent 'integrative' theories (*idem*). This designation simply amounts to the fact that "analysis is treated dispersively by formism and integratively by mechanism, and synthesis is treated dispersively by contextualism and integratively by organicism" (*idem*); it implies that 'facts' in dispersive theories, independently from where they originate, tend to be taken "as they come and so are left" (*idem*) and are interpreted as 'multitudes.' The result is the *proliferation* of facts. The 'structural categories' tied to these theories envision the world as only loosely held together and thus as a relatively *weakly determined* place (cf. *ibid*.: 142f.). The 'structural categories' of the 'integrative' hypotheses, by contrast, sketch the world as tightly held together and hence as a relatively *strongly determined* place (cf. *ibid*.: 153). The latter leaves little leeway for 'chance' and emphasises the strict systematicity of worldly phenomena. The implication is that 'integrative' world hypotheses try to develop 'precision' and therefore tend to explain away or further decompose many of the facts they discover; these theories are hence more than prepared to face the *negativity of fact*, whereas the 'dispersive' world theories attempt to develop their faculty of 'scope' by drawing together a broad latitude of *positive evidence* in the hope to multiply their corroborative power.

The opposition between 'integrativity' and 'dispersivity' is therefore directly tied to the polarity between 'scope' and 'precision' in world hypotheses. The types of *cognitive inadequacies* which are characteristic for each of the four theories are strongly tied to this general configuration (cf. Pepper 1942: 143; see **Appendix II.2** for a detailed exploration of these inadequacies). World hypotheses that tend to 'freely' incorporate all facts and are not so much concerned with the appropriateness of these facts – 'dispersive' theories – are "chiefly threatened" to suffer in 'precision' while having little trouble with improving their 'scope' (*ibid*.: 143f.). Complementarily, world hypotheses that tend to carefully select their facts or to limit them *a posteriori* – 'integrative' theories – usually excel in 'precision' yet tend to lack in 'scope' (*ibid*.: 145) This overall structure of world theories has profound implications for how evidence can be gathered and interpreted; the 'integrative'-'dispersive' polarity can hence be expected to severely affect how scholars are able to make sense of their object matters in the various theatres of scientific practice.

Moreover, it can be noted that due to the natural arrangement of world hypotheses into two groups of two, eclecticisms are greatly encouraged precisely at the resulting junctures (cf. Pepper 1942: 146-150). As a consequence, 'formism' and 'mechanism,' since they share an 'analytic' conviction, exhibit a strong tendency to combine in practice (cf. *ibid*.: 146-148, 184f.); the same can be said for 'contextualism' and 'organicism,' which often seek cognitive alliance and tend to merge in practiced research since they both rely on 'synthetic' imperatives (cf. *ibid*.: 147, 280).[95] For the same reason, 'analyticity' and 'syntheticity' tend to exclude one another – their relationship tends to be of an 'antithetical' nature. The members of these two groups are inclined to reject each other's basic premises, sparking mutual hostilities which may or may not be consolidated in the course of cognitive history.

However, the relationship between 'integrativity' and 'dispersivity' is more ambiguous. Cooperation between these two groups is often favoured because the two appear to perfectly complement each other, so that 'scope' and 'precision' can be developed *in parallel* because both can help each other where they are weak. The consequence is a structural predisposition to join the two and to draw on them in pairs. This is why there generally exists a strong tendency among eclecticists to mix 'formism' with 'mechanism' (cf. Pepper 1942: 184f., 220) and to amalgamate 'contextualism' with 'organicism' (cf. e.g., *ibid*.: 278f., 280).[96] It is more than likely, however, that these gravitational forces play out differently in different disciplinary settings and with respect to different scientific problems – a situation which should not obscure the view for the sensitive role of these dynamics in organising basic cognitive conflict and allegiance yet shows that careful case-by-case assessment is always necessary.

Before we turn to the exposition of each world hypothesis' detailed cognitive structure and its unique canon of concepts, it seems important to shortly pause and to utter a note of caution first. Not

[95] In fact, Pepper (1942: 280) even finds it tempting to consider 'contextualism' and 'organicism' as a "species of the same theory, one being dispersive the other integrative."

[96] Other fusions are of course also possible, although less likely, and Pepper notably discusses the option of combining 'mechanism' and 'contextualism' (Pepper 1942: 147). He, however, ultimately rejects this kind of eclecticism as a viable solution, and I would argue that the main reason is the structural inability of scholars to satisfactorily bridge the 'analytic'-'synthetic' divide.

all science is necessarily 'good' science, and the structure of world hypotheses does not change this situation. The perspective opened up by Pepper's world hypotheses theory is therefore not a cheap way of rendering 'bad' science immune to critique, nor all of science for that matter. 'Analytic' world theories can of course do a poor job in the analysis of their parts, 'integrative' theories can do an insufficient job in specifying and integrating relevant facts, and so forth. Just because the scientific interpretation of facts is always driven by at least one hypothesis of world-wide scope does not mean that this interpretation automatically does justice to the hypothesis – that is, to 'tap' into its full interpretive potential. Having said this, we can begin now with the stepwise development of the four relatively adequate world theories and their distinct cognitive space.

2.4.2 *Formism*

The root metaphor of formism is 'similarity' or 'form and matter,' depending on the variant of formism that is conjured (cf. Pepper 1935a, 1942: 151).[97] Formism is an 'analytic' world theory and consequently considers parts as fundamental and wholes as derivative. Formists typically identify these parts as 'particulars,' i.e., entities which can be distinguished from other entities on the basis of qualities, properties, traits, attributes, and other part-based characteristics (Pepper 1942: 152-154; see **Box 6**). These part features may be regarded as parts themselves. In general, 'particulars' and their features are said to populate the 'observable' world.[98] 'Characters' specify the qualities of 'particulars' and the relationships that exist between them (*ibid.*: 154f.). Any entity may have an infinite number of 'characters.' 'Ties' capture the specific combinations of 'particulars' and 'characters' that can be observed in reality (*ibid.*: 155). Formism is all about mapping out parts in terms of these categories and to analyse whether and how they help to delineate wholes. The investigation of reality therefore amounts to the assessment of *similarities* and *differences* among 'particulars,' 'characters,' and 'ties.' The kind of similarity that is usually looked for is the recurrence of recognisable forms (cf. Hayes et al. 1988: 99). These inter-part relations are examined in terms of 'participation,' that is, the regular associations of 'particulars' and part-based features (*ibid.*: 154, 170). Different 'particulars' may for example participate in similar 'characters' and varying 'characters' may participate in higher-level 'regularities,' 'norms,' or 'laws.' This participatory structure of reality creates *patterns*. These patterns, conversely, are regarded to be informative about the *deep fabric* of the world and its observable phenomena. Hence, the determination of 'laws of association,' patterned regularities, and other pattern-generating principles constitutes the prime objective of formistic analysis. 'Attribute-analytical' approaches and trait-based statistical analyses represent a hallmark of this cognitive endeavour.

As a 'dispersive' world theory, formism is interested in the *proliferation* of fact and tends to invest a lot into *ordering* the evidence which is available to it. Since formists study relationships among 'particulars,' 'characters,' and 'ties,' they effectively chart their overlap and non-overlap. Formism, in other words, is often motivated by a general 'theory of sets.' Overlapping sets of parts and their features, according to formism, indicate correlated aspects of reality. Most formists also draw on the 'Theory of Types' (Pepper 1942: 156-159). This theory is foremost a logical conception and states that "the concepts employed in the analysis of other concepts cannot themselves be included among the concepts analysed" (*ibid.*: 156). The theory systematises the formistic distinction between 'ties' and relations and helps to group 'particulars' in terms of similarity. A 'type' is nothing else than a set of 'particulars' that share certain 'characters'; 'types' may capture varying degrees of similarity between 'particulars' and may therefore be more or less complex. When the type concept is utilised to describe the structure of evidence in a systematic and comprehensive way, the result is the development of 'typologies,' 'taxonomies' and 'classifications' (*ibid.*: 159-162). These are logical constructions which organise the relationship among 'particulars,' 'characters,' and 'ties' in terms of participation, from the

[97] As a matter of fact, Pepper (1935, 1942) associates 'similarity' with what he terms 'immanent formism' and regards 'form and matter' as the core heuristic of what he calls 'transcendent formism'.

[98] I am somewhat careful with the notion "observable" here since observability in world hypotheses is also judged via internalised standards. Moreover, there is an extensive debate on 'scientific observation' and what it amounts to in philosophy of science. The problem of *direct* vs. *indirect observation*, as well as *natural observation* (i.e., observation via the naked eye) vs. *technical observation* (i.e., observation that is only made possible by technological aids) are all at stake here. The problem of observation is typically radicalised in the historical sciences since it remains largely unclear to what effect the past can actually be observed (cf. e.g., Turner 2007).

more general to the less general. While the total sum of a given set of 'particulars' tends to share not a single 'character,' only a single 'particular' typically answers to a whole range of different 'characters' (*ibid.*: 160). As a general rule one can thus conclude: the fewer 'characters' are shared, the more general the respective *class* of 'particulars.' *Classification*, i.e., the hierarchical organisation of classes, is a formistic key operation to determine order and the categorical interrelationships that govern reality (*ibid.*: 159f.). Classes or types supply the complex entities that formists may employ for further analysis – they may themselves be recast as 'particulars' to be examined in terms of their participation in patterns.

The 'Theory of Types' motivates the explanation of less inclusive categories by more inclusive ones (cf. Pepper 1942: 160). A 'class,' in other words, may simply be explained by placing it into another, more general 'class.'[99] The use of classification in this sense is not only heuristic but helps to delineate the determinative structure of reality. Explanation thereby focusses on the 'web of ties'; it tends to be externalistic and subsumptive. The formist generally believes that climbing up the 'ladder of participation' is a first and necessary step towards knowledge about the operative principles of reality. Describing the structure of co-variation thereby facilitates the recognition of regulatory relationships, i.e., which parts regulate other parts and in what way.

Formistic logic suggests that 'matter' takes specific 'forms' because of reasons not rooted in matter itself.[100] 'Form' is 'shaped matter' and there must be something in the world that has given or imposed shape on this matter. The ancient Greek notion of 'hylomorphism' – i.e., that 'form' is different from 'matter' and reality basically a configuration of the two – resonates with this conception. Since observable patterns are expressive of particular matter-states, there must be something essentially non-observable explaining them. Plato has identified these non-observables as 'ideal' categories or *eternal ideas* underpinning the patterns of reality. Patterns may similarly be explained by abstract or invariable concepts. 'Particulars' can then be said to *instantiate* or *exemplify* these non-observables. Conversely, the respective non-observables are the precondition for the presence of specific 'particulars' and that one can observe them under certain conditions. This *conditional* interpretation of 'particulars,' 'characters,' and 'ties' indicates that the materialisation of the observable parts of reality is mediated by well-defined 'principles of exemplification' (Pepper 1942: 163; cf. **Box 6**). Formism traditionally distinguishes between 'norms' and 'laws' as the relevant non-observable determinants (*ibid.*: 164-166). 'Norms' and 'laws' have two characteristics: (i) they regulate the materialisation of parts and (ii) resist complete materialisation. They can never be fully materialised because logic forbids that they are identical with the objects and patterns they purportedly explain.[101] 'Laws' are often defined as the principles or 'rules' that explain or bridge the correlated patterns of two sets of 'particulars,' 'characters,' or 'ties.' 'Norms' describe conditions of *normality* (i.e., trends, averages) that administer patterns of variability (*ibid.*: 164f.).

This particular understanding of 'norms' and 'laws' forces formism to make a categorical distinction between the realm of 'existence' and the realm of 'subsistence' (Pepper 1942: 167f.; cf. **Box 6**). The realm of existence is populated by the categories of observation, that is, 'particulars,' 'characters,' and 'ties.' The realm of 'subsistence,' by contrast, is populated by those entities which resist complete materialisation but remain necessary to explain the categories of 'existence.' While the categories of 'existence' are *concrete* – one may speak of 'concrete existence' here – the categories of 'subsistence' remain *abstract*. Both can be said to 'exist,' but in a different sense of the word. A 'law' usually *subsists* because it resists complete materialisation and is primarily defined by its *form*, that is, by a set of 'particulars' having certain 'characters' participating in the 'law' (cf. *ibid.*: 176):

[99] An implicit 'theory of sets' is sometimes also used to make sense of 'laws' or other 'regularities.' In 'formism,' these are often interpreted as a bridge between one set of basic particulars and another set, thereby determining the defining characters of one set by those of another set (cf. Pepper 1942: 177).

[100] Clearly, this tendency marks the irreversible point of divergence between 'formism' and 'organicism' since the distinction between 'form' and 'matter' does not allow for the possibility that change in a given object is ultimately induced by the object itself – a classic doctrine of 'organicistic' logic. The rejection of this doctrine is perhaps the strongest common denominator uniting the 'analytic' world theories under a single banner.

[101] Plato's allegory of the cave is the prototypical example of this formistic conceptualisation: what we perceive and observe in reality is merely a "shadow" of more basic entities whose existence we can only infer. These are, however, the precondition for the "shadows" we observe. These "shadows" can further be said to reflect some aspects of the 'ideal' categories that "stand behind" them. In order to explain the "shadows" we thus need to come to an understanding of the categories that condition the existence of each single "shadow." In other words, we need to understand the 'norms' and 'laws' that regulate the occurrence of specific "shadows" under particular conditions.

> "According to a Platonist, a law *subsists* even though it were never exemplified in concrete existence. An Aristotelian would be less bold, would agree that a law subsists by the definition of form as opposed to particular, but would declare that a law has no being outside of its exemplifications. It is, however, very important to notice that in formism a law is not to be identified with a concrete existent structure. Whether Platonist nor Aristotelian, for formist a law is a form. This is one of the fundamental distinctions between formism and mechanism. These two world views contradict on this issue. And the question is whether an Aristotelian is not hedging so as to avoid the full import of his contradiction. If one wishes to get the sense of formism in clearest relief, he does better to take the view in bold Platonic terms. Later he can consider whether an Aristotelian can hold his more moderate position without self-contradiction." (Pepper 1942: 177; original emphasis)

Since formism seeks to 'get to the bottom of things,' the patterns that are created by the participation of observable parts in non-observable 'forms' are ultimately to be explained by reference to at least one 'subsistent' category.[102] The 'form' concept therefore has a double significance in formism: it not only describes particular matter-states ('shaped matter'), but also the regulatory ensemble of observables and non-observables which is responsible for patterns of participation. A 'form' in the latter sense is a complex correlation between the relevant categories of explanation. In formism, different categories may therefore take part in different 'forms' at the same time and the potential *interference* of counteracting 'laws' and 'norms' must always be taken into account (Pepper 1942: 178). This constant possibility of 'interferences' is another reason why formism remains preoccupied with isolating 'normal' data-behaviour and 'normal states' of existence in general.

Although formism assumes that the categories of 'existence' are systematically *correlated* with the categories of 'subsistence,' the transition between the two is always problematic and requires heightened epistemological attention. Because explanation consists of a 'form,' the relationship between 'existence' and 'subsistence' tends to conceptualised as being relatively symmetric, so that a substantial change in one realm seems to imply a substantial change in the other or, alternatively, indicates an entirely different form. A natural way of elucidating the connection between 'concrete' and 'abstract' reality is by invoking the concept of *supervenience* (cf. Davidson 1970; Kim 1984, 2002; Bader 2013; McLaughlin and Bennett 2018). 'Supervenience' strikes a balance between correlatedness and categorical autonomy by asserting that different 'levels of existence' need to be acknowledged in their discreteness, but nonetheless appear to be *structurally interlinked*. Alterations on one 'level of existence' are therefore necessarily bound to adjustments on another level. What level is more basic does not matter in this regard.[103] This perspective showcases the categorical looseness of formism insofar as contingency and chance are granted and determinative relationships tend to be conceptualised in fairly generic terms.

In formism, the problem of *equifinality* is less serious than in other world theories. The reason is that formism has no trouble with accepting that particular matter-states may exemplify different 'norms' and/or 'laws' at the same time. Observable forms of 'particulars,' 'characters,' and 'ties' may simply be the *co-production* of different 'subsistent' categories. Nevertheless, forms still need to be specific to a certain degree. Only then is it possible to meaningfully discriminate between distinct 'laws,' 'norms,' and other 'subsistents.' A popular strategy to mitigate this problem is to enlist a range of competing 'subsistent' categories and narrow it down by means of exclusion. This procedure typically entails an 'abductive' argument specifying why particular 'subsistent' categories are better candidates of explanation (*sensu* Harman 1965, cf. Lipton 2001; Queiroz and Merell 2005). In general, formism interprets 'equifinality' as the problem of different forms being responsible for similar patterns of participation. 'Equifinality' is therefore the problem of finding the relevant or matching 'subsistent' categories. Issues of 'equifinality' are thus difficult to overcome by means of analysis and/or inference alone and formists rely on explicit non-formal argumentation here ('This category is likely to be more relevant because of X and Y'). 'Equifinality' is generally described as *multiple realisability*, i.e., the fact that more foundational categories of existence may be *realised* in rather different ways in

[102] Whether such 'subsistent' categories are dependent on the entities they "particularise" and if so to what degree is a lively debate among formistic thinkers – a debate which historically led to the separation between Platonists and Aristotelians (cf. Pepper 1942: 168).

[103] This is the basic difference to 'mechanism,' which conceptualises the link between different levels or domains of existence in terms of directed causality. There is thus a basic asymmetry between 'cause' and 'effect.' This is why in 'mechanism' the problem of *equifinality* is typically mitigated by exploiting the 'specifity of response' principle, for example by juxtaposing theoretical deductions and empirical patterns.

the more 'concrete' layers of existence (cf. Kim 1992; Bickle 2016). One therefore needs to identify the 'principles of exemplification' to gauge the spectrum of observable correlates of a given 'subsistent' category. Understanding the mediating principles that link 'existence' and 'subsistence' is of course a critical requirement to adequately interpret 'supervenience' (see *supra*).

Since formism is centred on the determination of patterns in 'concrete' reality and strives to identify regularities and 'normality conditions' that drive the behaviour of parts, it lends itself to quantitative approaches and statistical methods. Due to its 'dispersive' character, it is generally susceptible to 'big data' approaches. Statistical analogy-building, for example, is also a classic formistic manoeuvre since such a procedure isolates 'ideal' features of comparative data sets, i.e., trends and averages, to illuminate the analysed data sets in terms of these features. 'Analogy,' 'identity,' and 'correspondence' are simply manifestations of the formistic root metaphor of 'similarity.'

The guiding philosophical school of formistic reasoning is *realism*. The historical progenitor of formism, according to Pepper (1942: 141), is 'Platonic idealism' or 'Aristotelian naturalism.' Formists often pay particular attention to shape-based object properties – 'morphometrics,' for instance, may be viewed as the 'perfect' approach to assess 'shaped matter' – formists suspect that similarities and differences in this domain are likely to inform us about the corresponding 'subsistent' features of reality. Formism is generally straightforward in how it operates and makes sense of what it observes. This conforms to the strength and epistemic appeal of the similarity metaphor. Formism is often said to be 'unexciting' yet extremely 'reliable.' Among the four world hypotheses, formism tends to be the strongest believer of the explanatory power of data *as such*. Formism generally regards 'existence' as the gateway to 'subsistence,' and not the other way around.

2.4.3 ***Mechanism***

The root metaphor of mechanism is the 'machine' as a species of functioning (cf. Pepper 1935a, 1942: 186). According to the mechanist, any whole can be understood as a machinery in which the parts are related to one another in some systematic way. Every part of the machine has a *functional* role to play. Since mechanism is an 'analytic' world theory and thus presumes the primacy of parts, the 'effective' parts of a larger machinery are discrete and do not change when relationship among them are formed; the parts, in other words, exist independently of their relationships or the wholes they propel (cf. Hayes et al. 1988: 99). As Hayes et al. (*idem*) correctly point out: "in any common-sense machine, some sort of force or energy is exerted or transmitted through the system to produce predictable outcomes." This is because the machinery is held together by some kind of *mechanism* specifying which parts effect which other parts and in what way(s) (cf. Bunge 2004, 2013). This principle can typically be captured by the 'push-and-pull' metaphor or the concept of 'cause-and-effect.' The point is that these inter-part relationships are highly *specific*, so that it becomes possible to foresee what a part will do given particular conditions. Following Bunge (2013: 590), any working machinery can therefore be recognised as an ordered quadruple of *composition-environment-structure-mechanism*. The machine is composed of 'effective' parts, operates in an environment and inaugurates its own mechanistic environment (parts are external to other parts), possesses a specific spatiotemporal structure defining the role and consequence of varying parts, and is governed by at least one mechanism integrating the whole and defining the latter's global functionality or effectiveness (cf. Pepper 1942: 191-195, 226). The working principles and organisational structure of the machine of course differ from case to case.

Mechanism distinguishes between 'primary' and 'secondary' categories (Pepper 1942: 192f., 201, 215-217; cf. **Box 7**). The 'primary' or 'effective' qualities of parts are the features, traits, and attributes which are necessary to explain how a given machine works. The 'secondary' or 'ineffective' categories, by contrast, refer to the qualities of parts which are dispensable for grasping the workings of the machine. They are regarded as 'derived' features of the world and to be the result of the specific configuration of 'primary' categories associated with them. Mechanism seeks to describe the *compositional* structure of reality, but unlike 'formism,' which often targets 'agglomerates' since order is not presumed to be categorical there, mechanism aims to isolate *systems*, i.e., structured configurations of parts. Facts are assumed to externally match because order is categorical (*ibid*.: 143). This is the 'integrative' side of mechanism. The goal is to incorporate the parts of reality in order to clear the view for a single functional whole.

Mechanism often embraces implicit 'field theories' (cf. e.g., Martin 2003). The structure of the sought-after compositional entities comes into view as a 'field of locations' (Pepper 1942: 197-200; cf. **Box 7**). This field defines the exact spatiotemporal position of each part in the machine. The relationships between parts can thus be understood as a function of the exact 'location' of their 'primary' qualities (*ibid.*: 191). Importantly, each spatiotemporal position can only be occupied once. In mechanism, it is quite common to capture this 'field of locations' in mathematical equations and to express the work of parts in precise quantitative terms. The 'primary' qualities tied to two or more 'locations' are directly responsible for the type of 'action' observed between these 'locations.' In this way, each machine can be defined in terms of a 'primary law' (*ibid.*: 193, 207). This 'law' accounts for the specific configuration of 'effective' qualities in a given 'field of locations.' Because of the well-defined and largely fixed spatiotemporal structure of such a machinery, different 'locations' may also be identified as distinct *events* following up on each other in a *sequential* manner. The respective mechanisms at play render this chain reaction of parts (stimulus-response principle) largely *inevitable* (cf. *ibid.*: 226f.). Inevitability is thus a property of relationships between 'primary' qualities, whereas 'accidental' outcomes may be generated only by the 'secondary' qualities (*ibid.*: 196f.; cf. **Box 7**). Depending on the type of mechanism embraced, accidentality may be granted to some degree or denied altogether.

In 'consolidated' variants of mechanism, the 'field of locations' describes a *fully integrated* and *determined* field structure, so that almost no discreteness is left (cf. Pepper 1942: 212-215). This notion of the 'field structure' simply expresses the mechanistic conviction that a single underlying entity furnishes a highly consolidated structure of space-time particulars, so that everything in the field obeys to the 'laws' and 'principles' tied to this structure. The field structure consequently emerges as the only genuine 'effective' category and everything that populates it is recast as 'secondary.' Completely integrated field structures thus define space-time *singularities*. They give witness to the mechanistic intuition that, ultimately, only a single highly consolidated particular 'exists' (*ibid.*: 214). Causally integrated field structures shed light on the 'geometry' of the world (*ibid.*: 212).

A key feature of mechanism is that explanation is typically equated with the ability to *predict* (see 2.6.2). For mechanists, prediction is the consequence of having pinned down the relevant 'primary' qualities, the 'field of locations,' and the 'laws' and 'principles' regulating observable 'action' in the field. Since mechanism usually explains in terms of causes, i.e., factors that regularly precede or coincide with whatever is to be explained, a large part of the observable outcome is highly specific and inevitable. It is a necessary consequence of the configuration – or *modus operandi* – of the machine. The respective observations, in other words, turn out to be 'unsurprising.' Therefore, one effectively explains a feature of reality if one can show that this feature was a necessary and largely unsurprising outcome of the responsible machinery. Explanation therefore tends to revolve around principles of determination – explanation can only be 'subsumptive' if particulars are shown to be systematically linked to more general aspects of realty by means of a specific mechanism – and knowledge is secured by matching predictions and observations.[104] Mechanists are the champions of fine-grained and mechanism-specific *hypotheses-testing* and often employ *hypothetico-deductive* modes of reasoning (cf. Hayes et al. 1988: 99).[105] This not only mirrors the 'integrative' quality of mechanism, but also takes up the idea that most observable features are 'derived'; mimicking (or re-enacting) the process of generating them in theory should consequently provide primary insight(s) into their 'existence.'

Mechanism sharply distinguishes between 'pattern' and 'process' and interprets the relationship between the two as a one-sided dependence (cf. **Box 7**). Patterns describe observable regularities, co-associations, and correlations, whereas processes stand for the underlying structure of reality giving rise to particular patterns. Similar processes, therefore, bring forth similar patterns, but similar patterns do not necessarily indicate similar processes. This introduces the problem of *equifinality* which

[104] Bunge (2013: 591) is very clear about this general 'mechanistic' orientation when he asserts: "No law, no possible mechanism; and no mechanism, no explanation. No wonder then that the hallmark of modern science is the search for the mechanisms behind the facts, rather than the mindless search for data and the statistical correlations among them.

[105] The key difference to 'formism' is that the latter employs hypothesis-testing to assess the *structural congruity* between the hypothesis and the empirical observations. The mobilised hypotheses therefore tend to be rather general and fairly generic. They reflect the 'formistic' search for explanatory 'subsistent' categories. Exact and fine-grained consequences of particular mechanisms are rarely incorporated or do not constitute the main thrust of the analysis. Whereas 'formism' subsumes the particular under the general because 'laws,' 'regularities,' and 'norms' are seen as *forms* of participation, 'mechanism' seeks to connect 'primary' qualities and to analyse their correlated 'derivatives'; for a 'mechanist' a 'law' is not a form but a concrete structure of existence, i.e., the specific configuration of 'primary' and 'secondary' categories in a working machinery.

mechanism interprets as different processes producing similar patterns (cf. Beven and Freer 2001; Mayhew 2015). The difficulty is thus to bridge the gap between the 'primary' and 'secondary' categories and to effectively negotiate the problem of *Appearance and Reality*. Typically, 'reality' is only granted to the 'effective' categories of mechanism and the 'ineffective' categories are thought to describe mere 'appearances.' Appearances are 'derived' in the sense that they can hardly claim independent existence. What one can directly observe, that is, without any technological aids, is usually a mix of 'primary' and 'secondary' qualities, the latter often outnumbering the former. A field structure, however, is an example of an unobservable compositional entity which needs to be postulated in order to explain the organisation and behaviour of its parts. Observability is thus often used as a proxy for the relative 'derived-ness' of the elements of reality, the golden rule being "the easier to observe, the more derived the phenomenon appears to be."

This epistemological configuration greatly predisposes mechanism, especially in its radical guises, to explain away the 'ineffective' categories of reality and to deny their actual existence – these qualities are then simply viewed as *epiphenomenal*.[106] This brings up the old issue of *reduction*, and mechanism struggles with it since its inception. If the 'secondary' categories turn out to be entirely 'ineffective' or can be completely reduced to their correlated 'primary' categories, they do not explain anything in the world. Part of the 'integrative' task that a mechanist has to do is thus to discriminate between the 'effective' and 'ineffective' features of a machine – a task that simply amounts to the evaluation of explanatory relevance. Mechanism holds that a recurrent obstacle of successful explanation is our inability to distinguish between 'effective' and 'ineffective' categories of reality. Much of what we observe is much more 'ineffective' than we like to believe – it represents the 'noise' generated by a highly interconnected world. In general, this situation has prompted many mechanists to populate 'dualistic' positions and to police categorical dichotomies such as 'body-mind' and 'nature-culture' in the hope to explain one category in light of the other (cf. Pepper 1942: 217-221). The central strategy is to *externally relate* these categories in order to demonstrate direct inter-category constitution or the 'non-reality' of one of involved categories. The 'mind,' for instance, is often recast as an 'ineffective' category of physical brain states representing varying circuits of 'active' and 'passive' neurons. Different domains of reality may similarly be analysed in terms of their status as 'effective' or 'ineffective' categories. The issue of *Appearance and Reality* generally provokes the *problem of transition* and insinuates the idea of a hierarchy of movers, with a 'first mover' on its foundation. As a result, mechanists strongly gravitate towards 'foundationalist' positions (cf. Schlick 1959; Triplett 1990; Bergmann 2004). If the world would be a chariot, mechanism would focus on the horses and *proximately* explain the movement of the chariot as a consequence of them pulling the wagon, while *ultimately* referring to a person sitting on the chariot and instructing the horses.

A crucial precondition of mechanistic knowledge formation is the explanatory stability of the determinative principles and causal relationships that it seeks to unveil. These provide integration to an otherwise chaotic reality. Mechanism is therefore typically committed to the doctrines of 'actualism'/'presentism' and 'uniformitarianism' (cf. Hoykaas 1963; Gould 1965, 1987; Cameron 1993; Henningson 2009). Historical contingency is therefore either explained in terms of the general variability of patterns related to the same processes or discarded as an 'ineffective' category altogether; there is no place for 'chance' or even 'sparks of eventuality' in a the world of a 'consolidated' mechanist. That determination is thereby increasingly conceptualised in terms of *statistical* effects and processes does not change this situation (cf. Pepper 1942: 143). Modern mechanists draw on computational methods and mathematical descriptions in order to tackle to 'integrated' nature of reality.

The guiding science for mechanism is mechanics or Newtonian physics. Mechanistic reasoning has sometimes been qualified as the thinking of the 'experimental scientist' (Bartlett 1958; Harris et al. 1977: 538). Reproduction/replication is thereby just another side of 'prediction' and re-creating patterns and original observations under laboratory conditions is both a preferred mode of corroboration and a promising exploratory strategy. The 'experimental mode of reasoning,' including the branch of computational modelling,[107] enables the precise specification of test implications and the assessment

[106] For the tenets of 'epiphenomenalism,' see e.g. Jackson (1982) and Bieri (1992). Generally speaking, an *epiphenomenon* is an entity that has been caused by another entity but itself has no causal efficacy anymore.

[107] Computational modelling may simply be defined as *virtual experimentation* since it recreates a systemic machinery including its environment, so that multiple variables can be adjusted in a virtual reality in order to assess the differential effects of these variables on the performance and outcome of the artificial machine.

of particular 'cause-and-effect' relationships (cf. Shadish et al. 2002); experimental approaches greatly facilitate the *causal adjustment* of the various components of reality under scrutinisation. In other words, experimental research helps mechanists to reconstruct the inner workings of real-world machineries by emulating them in a controlled setting.

The leading school of philosophy for mechanism is *naturalism* and *materialism*. As Pepper (1942: 141) points out, the development of mechanism is historically related to the work of Descartes, Hume, Locke, and Reichenbach. Mechanism regularly draws from 'behaviourism' and 'adaptationism' and is generally consistent with 'hard ecology' views, classic Darwinian evolutionary theory, most of the behavioural sciences (including classic ethology in the wake of Lorentz and Tinbergen), sociobiology, evolutionary economics, evolutionary psychology, and so forth.[108] Mechanism is the arch-enemy of what it perceives as 'naïve empiricism' and typically counters 'inductivism' by insisting on the *a priori* significance of general theory. According to hard-nosed mechanists, only general theory, through its predictive capacity, is able to provide convincing justification for the unobservable entities of the world's 'inner structure.' Mechanism thereby also defends the idea that the 'context of discovery' must not be conflated with the 'context of justification' (*sensu* Reichenbach 1938; cf. Nickles 2013). When the four world hypotheses are compared, mechanism is probably the strongest defender of the concept that *data ought to be tailored according to theory*.

Mechanism is appealing because it provides a simple and intuitive explanation for why certain facts are observable in the world: they are caused by other facts, typically by more 'basic' ones. According to mechanism, the world is not only a fully determined place, but also a vertically and horizontally structured one. The vertical structure of reality is particularly important in mechanism since it elucidates the *layered* logic of reality-constitution. Reality can be collapsed into a hierarchy of 'effective' and 'ineffective' categories – the former are basic the latter are derived.[109]

2.4.4 *Contextualism*

The root metaphor of contextualism is the 'ongoing act in context' (Pepper 1935a, 1942: 232; cf. Hayes et al. 1988: 100) or, more appropriately, 'situationality' (Pepper 1945; cf. Efron 1980: 31)[110]. Contextualists are widely known as 'relational thinkers' (cf. Harris et al. 1977: 538) insofar as their main targets of analysis are *relations* of various kinds (see **Box 8**). Contextualism seeks to explain in terms of the interplay between what is to be explained and its larger context. The key intuition that perpetuates the contextualistic project is the *context-dependency* or 'relationality' of any encountered fact. This enunciation stresses the inherent fluidity and flexibility of contextual articulations, so that nothing in the world can be taken for granted (Pepper 1942: 233f.). Contextualists, therefore, often applaud criticism of *a priori* categories and typically doubt that such categories exist, can be known, or are valuable assets in understanding reality. For contextualists, there are no "absolute truths or standards" (Harris et al. 1977: 539) – the only certainty is that there is no certainty (Pepper 1942: 234f., 249); any entity or category of reality, in other words, is assumed to fundamentally *depend* on other entities or categories. By rejecting the 'objectivist' and 'absolutist' dogma, contextualism posits that any distinguishable feature of reality assumes its significance or meaning only by virtue of its contextual framing, i.e., the interconnections with other features of reality that share the same context of significance. Contextualism is a 'synthetic' world hypothesis to this effect. Parts are derived entities whose quality and existence rely entirely upon the wholes in which they occur. Moreover, since contextualistic inquiry tends to be 'dispersive' – that is, it promotes the *proliferation* of fact and the exploitation of the latitudinal margins of evidence – the same elements of reality may constitute parts of different wholes at the same time (cf. Harris et al. 1977: 539). Another consequence of contextualism's 'dispersive' quality is that

[108] See Bunge (2013: 590) for a list of mechanisms identified in the natural and life sciences, including Darwinian evolutionary biology.

[109] This general 'stratigraphic' vision of worldly order predisposes mechanists to embrace what Hahn (2013: 33f.) has prospectively called *layer-cake model* of cultural realities [*Schichtortenmodell*] (cf. **Appendix II.3: Fig. II.1**).

[110] In *World Hypotheses* (1942), Pepper referred to 'historic event' as the root metaphor of 'contextualism.' On another occasion, he also spoke of 'temporal process' as a good candidate for the 'contextualistic' root metaphor (Pepper 1935a). In *The Basis of Criticism in the Arts* (1945), however, he drew attention to the concept of *situation*, borrowed from Otis Lee (1944), as the perhaps more appropriate conjectural intuition (cf. Efron 1980: 31). Yet, in light of Pepper's own writings and what the present author identifies as the basic logic of 'contextualism,' it seems that the concept of 'situationality' most appropriately captures what Peppers 'contextualism' actually stands for.

there exists, at least in principle, an unlimited supply of parts since parts are derived features of reality and, as such, may be 'derived' in many different ways (Pepper 1942: 237; cf. Hayes et al. 1988: 101).[111] The derivation of facts, parts, or categories appears as arbitrary as in no other of the four relatively adequate world theories (Pepper 1942: 235f.). The reason lies in the contextualistic root metaphor itself. Any 'historic' or 'ongoing event,' the meeting point of past and present, represents a 'rich,' 'intrinsically complex,' and highly 'interconnected' incident of life (*ibid*.: 233) in which the parts by definition *interpenetrate*, so that they remain difficult to identify, name, or isolate (cf. **Box 8**). In contextualism, uncovering whole-specific relationships thus typically implicates to describe particular modes of 'interpenetration.'

The principle that nothing can be denied provides justification for 'novelty' and 'change' to assume categorical status, rather than being merely derivatives (Pepper 1942: 234-236; cf. **Box 8**). For this reason, no category may be assumed to register a universal feature of reality. Conversely, any context potentially carries the threads of freshness insofar as it may possess 'predominant or permeating structural features that other contexts lack' (*ibid*.: 234). Therefore, each contextual whole potentially fortifies a number of idiosyncrasies which may be critical for comprehending it. 'Particularity' and 'uniqueness' are thus typically assumed to be key features of reality. Whereas other world theories emphasise the world's orderliness (i.e., straightforward distinction between categories and their subcategories), contextualists tend to approve the possibility for disorder, alternatives, and the 'alien.' As a result, each context can be expected to articulate some kind of 'otherness' or 'alterity' and it is this quality that differentiates it from other contexts. A systematisation of this consideration leads contextualists to believe that the past was fundamentally different from the present; deep-history perspectives further radicalise this *problem of alterity*.[112] Contextualists are consequently sceptical of deploying direct analogies or pushing 'actualistic' inference too far, especially in historical research. 'Changeability' is also granted to seemingly foundational categories such as 'rationality' or 'optimality' – to the extent that, strictly speaking, there are no foundational categories in contextualism anymore. The theory is 'anti-foundational' to this effect and leans towards the methodological symmetrisation of the various features of reality it investigates.

Wholes are described in terms of 'quality' and 'texture' (Pepper 1942: 235, 237f., 246-252; cf. **Box 8**). Both categories can only properly be understood in their mutual interdependency and in relation to the other contextualistic categories that make up either of them (*ibid*.: 236, 238). The 'quality' of a context, for instance, may be defined in terms of 'spread' and 'fusion'; 'texture,' on the other hand, can be determined by referring to 'strands' and 'references' (cf. Hayes et al. 1988: 100). None of these categories, however, has an absolute meaning and all of them remain open to change and revision. In general, 'quality' denotes what one may term the 'total meaning' of a whole, while 'texture' designates the internal 'infrastructure' of the same, that is, the various grammatical interconnections that hold the whole together (cf. Pepper 1942: 238).[113] The 'quality' of a whole, in others words, denotes the full 'synthetic' quality of part-whole relations, insofar as the whole is substantially 'more than the sum of its parts'; 'quality' captures this total character (*idem*). From a contextualistic perspective, a whole is an *immanent* feature of reality. 'Texture' specifies the intra-whole structure which distinguishes the whole from other wholes and defines its specific internal heterogeneity and organisation; it portrays the part-interconnections representing the whole's 'domestic' details (*idem*). The fact that 'quality' and 'texture' are practically indivisible – one may only say that one is more prominent or relevant in one context than in another – showcases the 'cyclic' part-whole dynamics characteristic of contextualism and the

[111] That facts can be derived in many different ways and depend on their context, including that any number of facts may be 'derived' in a given context, resonates with the 'contextualistic' theory of cognitive criticism centred on the notion of 'operationality.' In 'contextualism,' cognitive 'veracity' is established rather pragmatically – by satisfying the needs and goal of a particular inquiry (cf. Pepper 1942: 268-278; see Section 2.6). Since explanation essentially amounts to 'successful working,' determining the effective parts out of the spectrum of possible parts is an essential part of the explanatory endeavour. Although 'contextualism' endorses the relativism of parts, it is therefore inconsistent with 'anything goes' approaches. The criterion of successful working itself is not negotiable.

[112] In its radical interpretation, the alterity principle establishes the exact antithesis to the 'mechanistic' doctrines of 'uniformitarianism' and 'actualism.'

[113] The example that Pepper provides here is the purposive act of writing a sentence: "[n]ow what is quality and what is texture in this event? Its quality is roughly its total meaning, its texture roughly the words and grammatical relations making it up. Generalizing, the quality of a given event is its intuited wholeness or total character; the texture is the details and relations which make up that character or quality." (Pepper 1942: 238)

latter's rejection of 'absolutisms' of any sort. Contextualism subscribes to the doctrine that parts are not separable from wholes:

> "[…] There is no such thing as a textureless quality or a qualityless texture. It follows that contextualism denies that these are absolute elements. It denies that a whole is nothing but the sum of its parts. It even denies that a whole is a sort of added part like a clamp that holds together a number of blocks. A whole is something immanent in an event and is so intuited, intuited as the quality of that very event." (Pepper 1942: 238)

Contextualism is the only world theory that takes 'fusion' seriously – all other theories marginalise it or explain it away as 'vagueness' (Pepper 1942: 245). 'Fusion' is the integration of the textural details of the whole; it explains why the different ingredients of a whole are so difficult to analyse separately (cf. Hayes et al. 1988: 100). The 'fusion' of parts, in other words, paves the way for the 'quality' of the whole in which all parts become one (cf. **Box 8**). With Pepper (1942: 245f.), one may add that 'fusion' exerts "an agency of qualitative simplification and organisation." The category of 'fusion' also elucidates why contextualism tends to conceive of the boundaries of different compartments of reality as 'permeable,' 'flexible,' 'expensive,' 'covering,' and/or 'overlapping': the 'total quality' of reality is simply regarded as a 'fusion' of all of its anchoring elements. This inclination to regard the borders between different domains of reality as generally 'blurred' and to interpret inter-domain relationships through the lens of 'interpenetration,' 'embeddedness,' or 'co-implication' leads to the recognition of reality as a 'blended,' 'mingled,' and ultimately 'messy' place. Reality, in this view, is always inherently complex and the distinction between its varying parts (e.g., the 'social,' 'economic,' 'symbolic,' 'cognitive,' or 'environmental') becomes somewhat arbitrary. Contextualism, therefore, engenders a strong 'anti-Cartesian' conviction and tends to pitch 'Cartesian' charges against other world theories. Its vision of cultural reality conforms to Hahn's (2013: 33f.) *pound-cake model* [*Rührkuchenmodell*] of world-making (cf. **Appendix II.3: Fig. II.1**). Again, contextualists insists that any 'fixation,' 'predefinition,' or 'stipulation' of categories and parts amounts to an epistemological declaration of bankruptcy.

'Spread' refers to the extended present of an act or a part in its wider context; it captures the spatiotemporal distribution of the whole's anchoring parts and the whole's spatial and temporal consistency (cf. **Box 8**). An individual 'act' or 'event' in context can be said to 'spread forward and back' (Pepper 1942: 239, 242) – it is 'ongoing.' In contextualism, 'spread' grants every whole an important *historicity* insofar as its parts derive from past agencies of various sorts. But any feature of the whole – its effective parts, acts, or events – also point forward in time, each offering a distinct "feeling of futurity" (*idem*). Wholes can therefore be said to 'develop' in the sense that they retain their overall 'quality,' yet continuously reorganise their 'texture' it in space and time. A whole, accordingly, has temporal 'duration' and geographic 'reach.' This contextualistic reading typically results in the emphasis of *qualitative time* and *temporality*, rather than dimensional or absolute time (cf. *ibid.*: 240). The reason is that time too is considered to describe a relational feature – put differently, each whole may possess a specific relationship with time.

The triplet 'quality'-'spread'-'fusion' clarifies why contextualism privileges *qualitative approaches* to the available evidence: its goal is to grasp and comprehend wholes and these are preconceived as fundamentally qualitative entities, as 'fusions' of spatiotemporally spread out but interconnected elements. 'Quality' in this sense implies *strong emergence* (cf. Hodgson 2000; Laughlin 2005; Chalmers 2006): wholes are expected to possess qualities and features which are not present in and not even necessarily implicated by the anchoring parts. Consequently, to close the gap between 'texture' and 'quality' usually requires *interpretive* and *holistic methodologies* that allow researchers to pinpoint wholes, 'to discern and differentiate their specific modes and, from these, arriving at more general forms' (Tomlinson 2018: 3). These "more general forms" represent nothing less than the varying 'qualities' of these wholes.

The 'grammatical' relations that determine the textual details of a whole can be characterised by two interrelated categories: 'strands' and 'references' (cf. **Box 8**). A whole's 'texture' is made up by 'strands' and these are located in a 'context' (Pepper 1942: 246). As Pepper himself (*idem*) remarks, discriminating between the two is difficult because the connection of the 'strands' determines the 'context' and the 'context,' in turn, largely determines the quality and character of the 'strands.' This reiterates the regulative idea of contextualism, that is, *co-determination*. Contextualistic determination tends to be 'multilinear,' 'multidirectional,' and 'multipolar'; it emphasises the 'co-formatting' of parts with *a priori* flattened hierarchies.[114] It is also 'cyclic' because parts determine other parts but are also determined by their whole(s). Determination is thus 'weak' and often 'distributed' but appears nonetheless to be 'thick.' In general, contextualism assumes radical 'elasticity' insofar as everything in the world is potentially shaped by everything else. A 'strand' is defined as anything that *directly* contributes to the quality of a 'texture,' while a 'context' is anything that *indirectly* contributes to it (*idem*). The general idea is that 'strands' constitute relevant details of a 'texture' but also reach out to their whole by resonating with a least one 'context,' thereby bringing some of the 'quality' of the whole to the 'texture' (*ibid.*: 247). 'Strands' are thus the building blocks of a whole's 'infrastructure' whose significance, however, crucially depends on the whole's 'quality.' An important implication of the construal is that there is an indefinite number of possible 'contexts' and contextualism is quick in delineating a whole range of significant 'contexts' and 'sub-contexts' (or 'macro-' and 'micro-contexts'), each bringing in its own 'quality' and 'texture' (*ibid.*: 249). Pepper (*idem*) refers to this as the "sheering effect" of contextualistic inquiry. 'References' reinforce this effect since they "simply consist of the strands more intimately considered" (*ibid.*: 252; cf. **Box 8**); they delineate aspects or features of 'strands' that help to determine the latter's position and role in bringing a 'texture' about. All of this reveals that *interaction* is a core category of contextualism – everything in reality, including the structural categories of the theory themselves, are considered as products of interactive relationships.

As contextualism capitalises the analysis of relationships and recognises change in its most radical form, it takes the potential *heterogeneity* and *difference* of relations extremely serious. Contextualists regularly caution against what they regard as 'naïve correlationism' demanding the admission and incorporation of other types of interconnections, some of which may contradict basic similarity assessments. Contextualism for example seeks to chart relationships that can be characterised as 'nested,' 'asymmetric,' 'transitive,' 'supplementary,' 'subsidiary,' 'complementary,' 'synergistic,' 'recursive,' and so forth. These relationships express constellations of 'strands' and 'references'; 'references' can be instance be 'linear,' 'convergent,' and 'instrumental,' or they can 'block' each other (Pepper 1942: ; cf. **Box 8**). In contextualism, similarity is merely one of many possible relationships and it holds no privileged position in analysis or explanation. Similarities are relevant either as a 'convergence' of 'strands' and 'references' or as a rough approximation of the 'quality' or 'texture' of two or more wholes (Pepper 1942: 254; cf. Hayes et al. 1988: 101). Since contextualism accepts radical 'novelty,' however, no two wholes can be strictly identical. This is why similarity postulates are always problematic for the contextualist. Contextualism's relational epistemology requires the arrangement and sorting or various, often dissimilar relationships. Understanding the configurations of 'strands' and 'references' in order to retrace the 'texture' of a whole and from there grasp its 'quality' is never a self-evident undertaking. This is the point where contextualists need to 'dis-level' reality; they, for example, need to establish relational 'prominence,' 'weight,' 'significance,' and 'hierarchy in order to make sense of the respective links between relationships. This not only presumes an interpretive import in organising relationships, but also clarifies why *qualitative-rational argumentation* ranks among the primary analytic operations in contextualism.

The root metaphor 'situationality' simply gives voice to the contextualistic certainty that nothing can be presumed and is 'fixable' (cf. Pepper 1942: 235; see *supra*); according to contextualism, every fact is *situational*. Each fact depends on its factual surroundings and the total orchestration of facts in its context(s) of significance. The concept of 'situationality' calls attention to this pervasive interconnectedness and relativity of individualisable elements; it highlights that *everything is always framed by something else* through mutual reference, reinforcement, or sometimes even through sheer ignorance. A 'situation,' according to Pepper ([1970]; cited in Efron 1980: 32) consists of a multitude of "purposive strands so far as they tangle and stick together" and is by virtue of the contextualistic categories 'novelty' and 'change' *unique* to this effect. Pepper's 'selectivism,' which he initially proposed as a fifth world hypothesis in *Concept and Quality* (1966), is generally consistent with this characterisation and is taken here simply as a variant of the contextualistic root metaphor. The 'purposive

[114] Cf. "Contextualism is accordingly sometimes said to have a horizontal cosmology in contrast to other views, which have a vertical cosmology. There is no top or bottom to the contextualistic world. In formism or mechanism or organicism one has only to analyse in certain specified ways and one is bound, so it is believed, ultimately to get to the bottom of things or to the top of things. Contextualism justifies no such faith." (Pepper 1942: 251)

act' can be understood as a special case of contextual framing, in which 'intentionality' and 'purposefulness' emerge as key qualities of a whole's 'texture.' Put differently, particular configurations of 'strands' and 'references,' especially if they turn out to be 'instrumental,' may reveal the directedness and implied intentionality in building up a whole's 'quality.'

Due to its critical elasticity and 'anti-foundationalism,' contextualism is perhaps most sensitive among the four world theories to issues of *equifinality*; contextualists are generally sceptical about isolated observations, independent of whether they pertain to form or relationships. Because each part or fact and even each relationship may take part in multiple contexts and different such contexts, conversely, may host similar parts or relationships, only a 'synthetic' examination of 'texture' and 'quality' may shield against misinterpretation. 'Equifinality' is usually conveyed as 'polyvalency,' 'ambiguity,' or 'equivocality.' Whereas 'formism' and 'mechanism' typically consider 'equifinality' as an inferential problem, contextualism recognises it primarily as a *problem of interpretation*. 'Equifinality' is not least a consequence of the 'dispersive' nature of contextualism, according to which an almost infinite number of parts may be derived from each whole – similar parts may consequently be derived from different wholes.

The leading philosophical school for contextualism is *pragmatism*. Its historical development is related to the American 'pragmatist school' with thinkers such as Pierce, James, and Dewey, but also to some influential strands in European 'philosophy of life' and 'existential philosophy' with authors such as Bergson and Sartre. It often heavily draws on 'phenomenology,' 'structuralism,' and 'symbolic interactionism.' Within the empirical sciences, contextualism holds for example strong bastions in 'interpretive ethnology' and 'historical anthropology.' Contextualistic inquiry is consistent with 'soft ecology' positions, and has produced various theoretical frameworks to describe and interpret interdependencies and webs of relationships in lifeworld contexts.

Contextualism is appealing because it is not easily satisfied with simple answers and because it recognises that anything in reality has its proper context. The theory thereby responds to the intuition that there is 'more to the world then first meets the eye.' Yet, the complexity of interpretation that it affords is also viewed as its most detrimental weakness. Non-contextualists typically reject contextualistic approaches because of their analytical complexity, often denounced as 'cognitively confusing' at best. Contextualistic investigation is regularly considered to be 'messed up,' decisively 'in-transparent,' 'muddled,' and overly 'subjective' by its adversaries (cf. Pepper 1942: 245). Contextualists counter by positing that 'simple,' unambiguously 'lucid,' and overly 'concise' scientific expositions are suspicious in themselves and represent over-confident projections since we cannot presume anything about the world before we have encountered it, including the circumstance that the world is 'well-ordered' and governed by some kind of organisational 'simplicity' itself.

2.4.5 ***Organicism***

The root metaphor of organicism is the 'living being,' 'organic integration,' or 'becoming' as processual individuation (Pepper 1935a, 1942: 280; cf. **Box 9**). The key category in organicism is *time* and its primary concern is with historicity, temporality, and evolution. Organicists in particular oppose the 'mechanistic' tendency to spatialise time and to interpret its categories from the vantage point of their spatial correlatedness, despite the common talk of 'spatiotemporal' existence. The epoch-making controversy between Einstein and Bergson about the relativity of time, which they both accepted, illustrates this clash between prototypical 'mechanistic' and organicistic modes of analysing time (cf. Canales 2015).[115] Organicism is all about accepting time as a basic category and to approach everything

[115] The clash between Bergsonian philosophy and Einsteinian physics marks a watershed event in the history of thought and anticipated some of the central divisions that would characterise modernity. This today largely forgotten 'Einstein-Bergson debate' can be understood as a prelude to the rise of science as the dominating intellectual force of the twenty-first century and the gradual decline of philosophy as an authoritative voice in society (cf. esp. Bergson 1922). Canales' *The Physicist & the Philosopher* (2015) offers an in-depth exploration of the intellectual, social, and historical context of this fascinating and potent controversy and interested readers are advised to consult his illuminating investigation. Canales (*ibid.*: 15; original emphasis) notes that "[t]he years that followed [Einstein and Bergson's] encounter in Paris can be compared to those of the religious wars – with one major difference: instead of debating about how to read the Bible, thinkers across a wide variety of disciplines debated about how to read the complex *unfolding of nature through time*." Even though Canales explicitly warns against oversimplification of the debate and the tendency to recast it in fixed dichotomies (*ibid.*: 36f.), the controversy between the "two giants" certainly illustrates some of the irreconcilable differences between 'analytic' and 'synthetic' thought, and especially between 'mechanistic'

else from a temporal point of view (cf. Pepper 1942: 308). Organicism, for this reason alone, furnishes the exact antithesis to 'presentism' and always theorises the *extended* existence of phenomena, escaping the grasp of momentary observation or 'static' snapshots. Organicists maintain that much interpretive confusion and difficulty derives from the fact that human observation is temporally limited and thus often misses the 'true' nature of whatever is observed. Pepper himself (*ibid.*: 280) notes that the 'contextualistic' root metaphor of the 'historic event' offers a good approximation of organicistic reasoning because of its emphasis on the *ongoing process*; for Pepper, the difference between the two theories simply lies in the circumstance that organicism interprets reality 'integratively' and insists on processual 'integration' when phenomena navigate their temporal existence. Organicism is essentially a 'contextualism' that recognises the 'absolute' or 'ideal' (*idem*). The paradox is that organicism – while holding on to the temporal perspective – seeks to explain away time (*ibid.*: 280f.). The reason is that phenomena, according to organicists, appear to be 'distributed' on the temporal plane and their *integration* thus consequently leads to the ultimate disappearance of the temporal factor (*ibid.*: 281). We must therefore specify what has been said previously: organicism takes time seriously only as a 'phenomenal' category, but not as an 'explanatory' one – explanation consists of *extracting* time from whatever is to be explained.

The core of the organicistic world theory is the tension between the 'phenomenal' and the 'ideal' (Pepper 1942: 281f.; cf. **Box 9**). The polarity between the two demarcates the distinct approach pursed by organicist to bridge the gulf between *Appearance and Reality*. The categorical dualism that comes with this approach reassures us that organicism constitutes an 'integrative' theory and as such is 'constantly tempted to throw out facts into the unreal' (*ibid.*: 145). The die-hard organicist believes that the 'phenomenal' or 'progressive' categories of reality are somewhat 'illusionary' and do not delineate concrete existence in the strict sense (*ibid.*: 282); they are, however, required to trace the corresponding 'ideal' categories and can thus not completely be abandoned (*ibid.*: 145). At the very least, the 'progressive' categories serve therefore an instrumental purpose. Organicism seeks to 'get to the top of things' and its goal is to integrate the 'progressive' categories in such a way that the 'ideal' they point to can come clearly into view. Organicism furnishes a 'synthetic' perspective to the evidence and the wholes it endeavours to describe and explain are thought to be *prima facie* withdrawn from direct observation. These wholes are regarded to be *internally heterogeneous* and difficult to pinpoint because of this. According to organicism, any phenomenal aspect of reality is underpinned by one or more 'concealed' organic process(es) which realise one or more 'organic structures'; the totality of an 'organic structure,' in turn, is nothing but the *achievement* of the 'progressive' categories striving towards their 'ideal.' Consequently, the organicist simply believes that any careful scrutinisation of reality reveals its underlying organic processes and that the associated organic wholes can be illuminated by, first, noting the successive 'steps' they pass through and, second, expounding the principal structural features which are realised in the process (*ibid.*: 281). Organic processes are therefore always 'directed' and 'irreversible' – organicists typically embrace a teleological perspective (cf. Hayes et al. 1988: 100). A proper understanding of the target processes does not only explain the phenomena under consideration, but also elucidates the general *logic* that guides the succession of and interrelation between the 'progressive' categories (cf. *idem*). It is through this mutual 'implicatedness' that organicism hopes to disclose the 'ideal' – even though each organicist knows that the 'absolute' can never fully be grasped because of its 'ideal' nature.[116]

---

and 'organicistic' interpretations of time. Whereas Einstein famously proclaimed that the time of the philosophers 'does not exist' (cf. *ibid.*: 15, 19), Bergson insisted on the fact that science can never hope to deliver a complete account of time since the latter entails aspects which cannot be entirely grasped by numbers or captured by instruments and mathematical formulae alone (*ibid.*: 10). For Bergson and his followers, time – epitomised in the concept of *duration* (*durée*) – involves irreducible *qualitative* aspects (*ibid.*: 24). Bergson's theory of time made space for memories, premonitions, expectations, and anticipations, while Einstein's theory of relativity focussed on 'objective' events and a theoretical understanding in which humans are principally dispensable. Einstein stressed the duality between *physical* and *psychological* time (object-subject dichotomy) (*ibid.*: 5f.), believed in the unity of the universe and the existence of immutable laws, and searched for consistency and simplicity. Bergson, in contrast, promoted an 'anti-absolutist' perspective in which relationality was foregrounded and radical change predicated; his universe is characterised by never-ending novelty and creativity – a view encapsulated in his notion of the *élan vital* (*ibid.*: 7). This Bergsonian point of departure naturally capitalises inconsistency and complexity (*ibid.*: 21). Einstein, however, sought to discriminate his theory from all sorts of cultural or artistic relativisms (*ibid.*: 33). Bergson, on the contrary, deliberately embraced a relativistic approach and maintained that determining time remains a complex operation 'necessitating the assessment of the overall meaning of a moment or event' (cf. *ibid.*: 36). Both thinkers accepted the centrality of time yet conceptualised its role in understanding the world in fundamentally opposing ways.

[116] Cf. **Appendix II.2** for a more detailed discussion.

There are three basic 'progressive' categories of organicism (cf. **Box 9**). The first category comprises what organicists identify as 'fragments of reality' (Pepper 1942: 290f.). These 'fragments' are the bounded units of observation, what the organicist would recognise as the 'appearances' of reality; these are necessarily 'incomplete,' 'isolated,' and 'scattered' and seduce the analyst to underrate the world's processual interconnectedness. For the organicist, engaging with the 'fragments' is both dangerous and necessary at the same time. It is dangerous because one might lose sight for what transcends the 'fragments' yet conditions their existence, namely wholes held together by organic processes; to engage intimately with the 'fragments,' however, proves necessary because they are the only reliable evidence for what organic processes aim for. 'Fragments of reality' are negatively defined: they 'acquire significance according to the degree of integration not achieved' (*ibid.*: 290). They represent, in other words, the material for integration – the *target* of organic integration. For this reason, 'fragments' can never be defined absolutely, but gain importance relative to integrations already achieved (*idem*). This point is important since it explains the inherent complexity of organicistic inquiry in which 'fragments' need to be integrated in order to clear the view for new 'fragments' to be integrated, and so forth. The result is a dynamic and potentially *deeply nested* interplay between parts and wholes. The concept of the 'fragment' thereby indicates that the parts are not arbitrary, but remain defined by their 'effectiveness' in facilitating integration. This conception bespeaks of the 'integrative' nature of organicistic thought. A 'fragment' is a component of reality that 'has no relevance away from the whole it is a part of, and once embedded in that whole it contributes to the totality without any separate status or meaning' (Harris et al. 1977: 538). The 'fragments' have the status of puzzle pieces; the crux of organicism is that the theory maintains that in order to know the pieces one must also develop a grasp of the total puzzle. This conception leads organicists to reject the idea of prediction since neither wholes nor parts unambiguously point to each other; rather, they co-determine one another in intricate ways and these ways can only be *diagnosed* in retrospect. For the organicist, the world consists of complex constellations of parts governed by implicit principles of unification (cf. *idem*).

The second 'progressive' category is represented by the organic 'nexus' (Pepper 1942: 291f.). 'Nexuses' specify the positive faculty of the 'fragments.' Each 'fragment' contains the internal propensity for completion, and it is this propensity that defines the *possibility* and *potentiality* to join different 'fragments' on the way towards organic integration. Thus, 'nexuses' delineate the space of positive interaction with other 'fragments.' According to Pepper (*ibid.*: 291), it is through their 'internal drive' towards integration that 'fragments' reveal the existence of organising 'nexuses.' As he contends (*idem*), organicists do not believe that facts are 'organised from without;' rather, facts are thought to "organise themselves." The structural category of the organic 'nexus' carries the tension between the 'possible' and the 'actual.' Both poles are co-constitutive because in order to know the actual, one needs to analyse the 'possible' and search for meeting points between 'nexuses.' The organic 'nexus' is thus a relational category and it practically makes no sense to speak of an isolated organic 'nexus.' The meeting point of different 'nexuses' can be conceptualised as a convergence or overlay between spaces of possibility. It is in this way that 'fragments' can be said to suggest their whole. 'Nexuses' are the mediating factors connecting parts and wholes. It is characteristic of organicism to approach actuality from the perspective of possibilities and potentialities – no other theory takes these aspects as seriously as organicism. The progressive triplet 'fragments'-'nexuses'-'integration' presupposes that particular constellations of 'fragments' and 'nexuses' can only be integrated in one particular fashion – they can only form a single organic whole. This is what is variously referred to as the fixed nature of wholes in organicism (cf. Harris et al. 1977: 538). Only then is it conceivable, for example, to meaningfully state that some pieces of the intricate organic puzzle are 'missing'; in the same manner as the parts suggest what is possible, the whole must be able to suggest what is lacking. The possible connections between the 'fragments' are invariant because organicism regards the world as a highly determinate place:

> "Newton's great insight was the transparency of vision which perceived the implications of the data as they were. Had he seen less clearly or tampered with the materials, the synthesis would not have been made: that is, not through him; but it would inevitably have been made soon. This inevitability of connections among fragments, this implication of wholeness contained in them, is what the organicist means by nexus. Every fragment, appearance, datum, fact, he believes, has nexuses. These are immediately discoverable in observation, he thinks, to anyone who looks for them. But better evidence still, perhaps, is the signs of their presence and action in the cumulative integrative process observable in the history of knowledge." (Pepper 1942: 292)

The third 'progressive' category is 'contradiction' or 'conflict' (Pepper 1942: 292-294). According to organicism, the world is made up by many counteracting forces and perceptual heterogeneity is regarded to be a genuine feature of the realm of 'appearances.' 'Conflict' among 'fragments' accounts for the circumstance that not all 'nexuses' are compatible and organic integration requires overcoming obstacles. There is a certain categorical 'resistance' to integration, at least when reality is approached from a static, momentary perspective. In other words, a basic imbalance between phenomenal categories is viewed to be the precondition for organic, time-consuming integration. For instance, 'fragments' that do not match initially may be transformed over the course of time so that they can finally be integrated. That "nexuses reach out from fragments like tentacles and encounter contradictions for the fragments" (*ibid.*: 292) thus reflects the organicistic certainty that there can only be one way of "puzzling" the 'fragments' together. The important point is that organicism thereby engenders an 'anti-correlationist' attitude: what appears to be inconsistent at first may become consistent at another point in time.[117] Understanding the nature of conflict, counteraction, and tension is therefore necessary to understand 'wholeness'; the latter is simply recognised as the outcome of a process surmounting or removing any remaining 'contradictions' among the 'fragments of reality.'[118]

Crucially, 'conflict' is thus also considered a key feature of many inter-whole relationships. Organic wholes, according to organicists, represent nothing less than higher-level 'fragments' currently resisting integration. This conceptualisation is key since it justifies the recognition of *domain-specific* behaviours and *rules of development* unique to prospective wholes. The organic process that facilitates the 'coalescence' of these quasi-autonomous wholes establishing an organic 'super-whole' is typically a lengthy and 'adversarial' movement – each whole promotes its own 'agenda' and integration consequently becomes a question of *coordination*. As a result, organicism often prioritises the perspective of the *longue durée* and insists on radical differences in how entities travel through time. For organicists, integration turns out to have been inevitable in retrospect, but the path towards it is always "stony" and resembles a drama full of tragedy (cf. *ibid.*: 293). In this view, reality consists of a continuous movement between 'thesis' and 'antithesis,' both co-implying yet also exerting hostility towards each other (*idem*). Organic 'synthesis,' as Pepper (*idem*) notes, consist of the higher-level acknowledgement of the respective claims of each 'fragment.' Unsurprisingly, organicistic approaches thus regularly deploy 'dialectical' methodologies.[119]

Because the "fragments cannot be regimented or restricted in number" nor is "the order of contradictions predetermined" (Pepper 1942: 295), organicists recognise the determinate nature of the outcome of organic processes, which is regarded to have always been implicit in the structure of 'frag-

[117] The rejection of what Quentin Meillassoux (2008 [2006]) has baptised *correlationism* is not identical with this 'anti-correlationist' attitude. Meillassoux's *After finitude* represents a potent critique of what, in the wake of Kant, has come to be known as the dogma that the external world cannot be known *outside* of its relationship with knowing subjects. Meillassoux (*ibid.*: Chapter 1, esp. 4) attacks this notion and argues that thought can actually discriminate between the 'phenomenal' – which always contains the input of subjects – and the 'absolute' which is subject-independent. Tentatively, *After finitude* can thus nonetheless be interpreted as a radical incarnation of 'organicism' insofar as its author rejects the 'analytic' insistence on the necessity of natural laws and of correlation as an methodological point of departure, but similarly repudiates the 'contextualistic,' especially hermeneutic, tendency to regard the human subject an ineluctable factor of knowledge formation. *After finitude* presents an attempt to salvage the organicistic 'ideal' and with it the 'dual' constitution of the world, without falling into 'mechanistic' necessities. This becomes most obvious when Meillassoux (*ibid.*: esp. Chapter 3) suggests an 'object-orientated' ontology to grasp the fabric of reality. This ontology stresses *object-alterity* and the *particularity* and *specificity* of subject-independent objects, classic themes of refined 'organicistic' thought (see *infra*). With Pepper (1942: 303), we can say that this Meillassouxian possibility to grasp the 'absolute' stems from the fact that 'organicism,' in theory, allows one to recognise the claims of the facts themselves, otherwise the 'fragments' simply resist their resolution (see *infra*).

[118] This constitutes a major difference between 'organicism' and all other world theories, especially 'formism' and 'mechanism.' For the latter, parts that do not 'match' or 'correlate' are typically regarded to reflect non-compositional relationships, that is, relationships that do not matter much for inferring or explaining wholes. 'Contradiction' and 'conflict' demarcate the terrain of negative knowledge for these theories; the field of positive knowledge, by contrast, only depends on them as it defined by conflict-free relationships.

[119] Dialectics is sometimes opposed to the 'scientific method' (cf. Dybicz and Pyles 2011) and clearly draws on a different epistemological basis. Dialectic thought has its roots in Continental European philosophy and is still widely applied in some branches of the humanities and social sciences. It plays almost no role in Anglo-American philosophy, especially its 'analytic' outposts. Popper's (1945, 1968) recurrent criticism of dialectics illustrates this situation. Popper (1968: 312) specifically lamented the dialectic willingness to 'put up' with contradictions, that is, to acknowledge their role as positive elements of knowledge (see also Bunge 1981, 2012: 84f. for a critique on dialectics; for the debate between Popper and Adorno on the status of dialectics, see Law 2015: 178). The European legacy of dialectic-critical thought is for example apprehended in Sartre's *Critique de la raison dialectique* (1960). Quite symptomatically, Scruton (1985: 186) – a conservative Anglophone philosopher – has accused Sartre's *Critique* to reveal a "total rejection of the rules of intellectual inquiry." From the foregoing, it should be apparent that this accusation is short-sighted at best and overlooks the simple fact that there is no single set of rules for intellectual inquiry, but at least four different cognitive frameworks delivering such orientation.

ments,' yet assert the particularity of the taken pathway. At the extreme, organicists maintain that evolution, or any other developmental process, follows a universal pattern (e.g., growth-consolidation-decline), but this pattern is realised in a myriad of different ways. In contrast to 'contextualism,' which interprets particularity as context-specificity, organicism thus re-casts particularity as the *specificity of developmental trajectories*. Notions such as 'cyclicity,' 'rhythmicity,' and 'modus of change' consequently anchor many organicistic approaches.[120] From this perspective, 'alterity' and 'otherness' emerge as potential features of long-term evolutionary pathways. Having said this, organicists may grant the possibility of epistemic anticipation, but only with regards to the general patterns of evolution. The specific trajectories themselves, by contrast, can never be predicted – they always have to be retrodicted and diagnosed.[121] Since organicism acknowledges change and conflict as the *status quo* of reality, the theory further shifts the burden of argument and explanation: change and contradictions can be assumed, while stability and stasis need to be explained (cf. Hayes et al. 1988: 100). This configuration is decisive since it remains largely incompatible with the 'mechanistic' proclivity to search for 'equilibrium conditions.'

Most organicists are 'stage-theorists' and this has to do with the specific link between the 'progressive' categories and the 'organic whole' they lead to. To recall, the 'organic whole' is nothing but the resolution of all relevant 'fragments of reality' in a coherent, yet typically extended system (cf. **Box 9**). Since 'integration' is conceived of as processual itself, the line of progression moves from one level to the next (Pepper 1942: 298): some 'fragments' become partially integrated and thereby form new 'fragments' which, in turn, may gradually be consolidated with both old and new 'fragments,' and so forth. This process is punctuated: gradual change culminates in *qualitative steps* of re-organisation. Each of these 'steps' or 'stages' increases the overall degree of inclusiveness, determinateness, and organicity of the whole under construction (*ibid.*: 298f.). The 'ideal' at which the process aims but never fully reaches is consequently characterised by the eradication of any trail of 'fragmentariness' since each systemic element then ultimately implies any other element and one cannot talk consistently about 'fragments' anymore.[122] In this vein, organic processes foster the gradual emergence of new levels of integration; 'novelty' – a 'contextualistic' category – is thus re-interpreted processually. For the organicist, gradualism and novelty are only contradictory categories if one adopts an overly static perspective on reality or relies on an untenable bivalent logic. In actual fact, however, the two can be considered to co-condition each other and to represent complementary extremities of the world.

The 'ideal' categories of organicism are simply the features of the 'organic whole' rendering it an outcome of aspiring the 'absolute' (cf. Pepper 1942: 304), that is, concrete and full-blown organicity. The 'ideal' categories methodologically threaten the 'progressive' categories since their purpose is to show that the 'progressive' categories are ultimately features of the realm of mere 'appearances' (*idem*; see *supra*). The whole point of organicistic inquiry is to pinpoint and resolve them since otherwise the 'ideal' remains hidden and is ultimately unknowable – to this effect, organicistic inquiry is itself cumulative and processual. The three 'ideal' categories of organicism are 'implicitness,' 'transcendence,' and 'economy' (cf. *ibid.*: 304-308; cf. **Box 9**).

---

[120] The very idea that (evolutionary) change follows a certain 'rhythm' is anti-mechanistic and a classic 'organicistic' figure of thought. The classics of this line of reasoning are, for instance, Bachelard (1932, 1936), Klages (1934; cf. Müller 2007), and, more recently, Lefebvre (1968, 1991, 2004) – all subscribing to a form of 'rhythm analysis.' It is notable that 'organicism' also hosts a range of theories that seek to consolidate radical developmental novelty with the idea of incremental evolutionary change. In palaeontology for example, a noteworthy but largely forgotten figure in this regard was Otto Schindewolf (1950) who advocated a theory of 'mutationism' (cf. also Allen 1969; Bowler 1978) – an approach that is often also referred to as 'typostrophism' (cf. Reif 1986: 117-120). A modern interpretation of this theory would hold that long-term evolution entails the possibility of the sudden emergence of new levels of organisation that are, strictly speaking, not predictable from their evolutionary starting conditions, yet are fully intelligible in retrospect (see the entry for 'strong emergence' in **Box 9**). More generally speaking, all of these views of evolution stress the 'creative' element of evolutionary processes.

[121] This is why 'organicism' and 'mechanism' disagree so blatantly on almost every issue – even though, ironically, both represent 'integrative' theories. For 'mechanism,' explanation and prediction are so intimately connected that an 'organicistic' explanation – which rejects the idea of detailed prediction – effectively amounts to no explanation at all. For 'organicism,' conversely, 'mechanism' fundamentally misconstrues the relationship between universality and particularity and overemphasises the importance of predictive faculties.

[122] Complete 'organicity' constitutes a dead end for organic processes. A condition in which each system-element implies any other leads to system-states in which the alteration or modification of their elements either changes the entire system or destroys it altogether (cf. Pepper 1942: 300). The organicist may interpret this theoretical end point as the natural point of breakdown of a given evolutionary trajectory. According to organicism, the termination of an entire evolutionary trajectory, in other words, may be explained on the basis of *internal categories* alone and does not require the postulation of an environmental trigger.

‘Implicitness’ refers to the fact that after discovering the organic whole, all ‘fragments’ can be shown to have always been a detail of this whole, occupying a well-defined spatiotemporal place in it, so that their apparent ‘fragmentariness’ turns out to be, strictly speaking, an error or illusion (Pepper 1942: 304). The mistake consists in the *prima facie* acceptance of discreteness where there was in fact an initially ‘concealed’ processual unity. Reciprocally, the whole can then be shown to have always be organised by its ‘fragments.’ In other words, to recognise the ‘implicitness’ of a ‘fragment’ means to understand where it ‘belongs’ to (*ibid*.: 305). The goal of organicistic inquiry is therefore to arrange ‘fragments’ in such a way that their nexuses connect and each fragment’s proper place can be grasped. ‘Transcendence’ is merely the other side of ‘implicitness.’ The whole can be said to *transcend* its internal contradictions rendering them ‘appearances’ too (*idem*). As soon as the whole is achieved, any contradictions either vanish completely (idem) or can be shown to be *local* contradictions only whereas the whole retains *global* unity. The general point that emerges from this is that the ‘texture’ of ‘contextualism’ (see previous sub-section) is itself subjected to change and transformation and a whole is thus typically invested with multiple ‘textures,’ each associated with a particular level of organic integration.

‘Economy’ pertains to organicistic interpretation insofar as each ‘fragment,’ although debunked as an ‘appearance,’ is nonetheless *saved* so that “nothing is lost in the absolute” (Pepper 1942: 306). Organicism is ‘anti-reductionist’ to this effect and endeavours to acknowledge reality of many layers of structural complexity (cf. **Box 9**).[123] Pepper (*idem*) remarks that “[n]othing positive is lost, and all contradictions vanish in the realisation of how these facts are connected.” ‘Economy,’ i.e., the preservation of all initial observations, is important in organicism because the theory seeks to respect reality *on its own terms* – as it ‘comes to us.’[124] The category of ‘economy’ gives rise to the organicistic credo of ‘unity in diversity’ and accounts for organicistic *unification* – that is, finding a whole-substitute for a group of distinct and at first sight counteracting parts. It represents nothing else than the refinement of the regulative idea that ‘fragments organise themselves’:

> “[…] The real strength in [the organicistic] argument comes from [the] analysis of evidence and the cumulative force of this analysis. A datum is a fragment with a nexus which leads to a contradiction that is resolved by an integration. This process comes spontaneously out of the fragment as the very activity of the nexus. Evidence progressively criticises itself and exhibits its own degree of reliability and points of itself to the ultimate structural organization of the world.” (Pepper 1942: 303).

In general, many organicists adopt ‘orthogenetic’ or ‘autogenetic’ perspectives on evolution and tend to reject the tenet of ‘heteronomy’ (cf. e.g., Varela 1979; Grehan and Ainsworth 1985; Csányi and Kampis 1985; Jonas 2001; Levit and Olsson 2006). Their justification is the supposed prevalence of ‘conflict’ and ‘contradiction’ and the conviction that the processes delineating organic wholes install critical whole-particularities and ‘object-specificities.’ ‘Orthogenesis’ is the idea that the evolution of wholes is guided by *intrinsic forces*, but contrary to common belief these forces are not mysterious at all;[125] positing such forces simply takes up the idea that wholes possess the capacity for *self-regulation*, *self-organisation* (*autopoiesis*), *self-assembly*, and, ultimately, *self-determination* (cf. Juarrero 1999; Deacon 2016). From a moderate point of view, this idea breaks down to the (much less controversial) assertion that the evolution of wholes is *mediated* by the (changing) structure of the respective wholes (cf. e.g., DeLanda 2015: 19).[126] This assertion, in turn, merely states that evolution can only ‘select,’

[123] The analytical focus of ‘organicism’ is *organisation* rather than composition: “[…] [w]e cannot explain organisms mechanistically because their organised forms are contingent, not necessary […]. Whereas a machine can be explained by analysing it into its parts, to explain an organism we need to grasp it as a unified whole that reciprocally determines the form and combination of every one of its parts” (Thompson 2007: 132, 136).

[124] Pepper (1942: 303) is correct to identify this is as a major strength of ‘organicism.’ The only way to meet this argument (that evidence has to be allowed to criticise itself) is to “deny the legitimacy of the organicistic critique of evidence”, and this is very difficult in the face of the cumulative corroborations of the evidence itself (*idem*). Pepper (*ibid*.: 304) goes on to assert that “for all other theories, their internal contradictions only confirm the organicist’s critique of evidence, and he would be triumphant if a basic contradiction did not break out in his own theory.”

[125] See for example Deacon’s (2011) proposal of ‘causality’ in terms of his complementary concepts of ‘orthograde’ (internal causation) and ‘contragrade’ (external causation).

[126] DeLanda (2015), for example, offers a demystified” approach to the ‘actual’ and the ‘virtual’ as complementary poles of reality. In classic ‘organicistic’ fashion, the ‘actual’ is thought to describe a state of ‘being’ observable in a given moment, whereas the ‘virtual’ designates the tendencies and capacities of particular matter configurations to change their ‘being’ – ‘virtual’ is this recast as a category of ‘becoming,’ opening what DeLanda terms a ‘possibility space.’ For an intuitive explanation of the ‘virtual’ in terms of tendencies and capacities, see *ibid*.: 19f.

'foster,' or 'develop' what is already in place. 'Autogenesis' is often used to refer to *emergent evolution*, that is, the possibility that synergetic and other whole-internal relationships bring forth novel whole-level properties in the course of evolution (e.g., Huttunen 2012).[127] At the extreme, both perspectives reject externalist accounts of evolution (including 'selectionist' and 'adaptationist' explanations), which in the view of many organicists effectively overlook the importance of the developmental claims and *potentialities* of varying wholes. Both 'orthogenetic' and 'autogenetic' interpretations typically recognise evolutionary *path-dependencies* and dynamic feed-back effects altering or reinforcing pre-existing pathways. Organicism, to the extent of no other world theory, acknowledges the *ontological autonomy* of wholes – it explains in terms of the *unfolding nature* of whatever is to be explained.[128] The key for explanation, in other words, resides in the phenomena to be explained *themselves*.[129] The employment of terms such as 'individuation' or 'concretisation' bespeaks of this processual and integrative logic of organicistic world-making.

The prototypical organicistic account of evolution is grounded in 'dynamic systems theory' in the wake of Ludwig von Bertalanffy (1950, 1973) and Gregory Bateson (1972, 1979), among others – organicism promotes 'systems thinking' (cf. Harris et al. 1977: 538). This thinking is *dynamic* because systems are not conceptualised as 'fixed' or 'static' entities, but as *plastic configurations* that develop and re-configure themselves (or are re-arranged) over the course of their life-history. Systemic developments, in this view, typically lead through a number of successive system-states before an 'ideal' state is reached – which, of course, rarely happens in reality. 'Systems' are not seen as atemporal, abstract skeletons, but rather as quasi-living, organic structures. This interpretation of 'systems' is different from 'mechanistic' readings where systems integrate the entirety of parts within a single quasi-atemporal field; the 'mechanistic' system has spatial and temporal coordinates but no temporality itself. Organicism, by contrast, sharply distinguishes between the 'being' or 'existence' of a whole – terms that simply describe the condition and state of a whole at a given temporal unit of observation – and the 'genesis' or 'becoming' of the same whole – the process that leads in a directed manner through a number of such conditions/states and thereby *connects* them. The 'life-metaphor' is strictly metaphorical here: organicism happily admits that not all wholes are 'alive' in the same sense. The theory exhibits a critical openness to all forms and kinds of 'living'; these different 'ways of living,' in turn, make room for much existential and developmental 'alterity' – the prime type of 'otherness' that organicists are sensitive for.

As a consequence of all of this, organicism seeks to shield its representatives from two different variants of *equifinality*: on the level of 'being,' 'equifinality' comes close to 'contextualitistic' polyvalency and concerns the circumstance that similar 'fragments' may occupy different spatiotemporal positions in an organic structure; on the level of 'becoming,' 'equifinality' comes close to the 'mechanistic' reading of the same by professing that similar parts or part-configurations may be the generated at different stages of the developmental chain. While the former pertains to particular system-states, the latter bears on the total evolution of a system. The distinction between these senses of 'equifinality' is

[127] In *Incomplete Nature*, Deacon (2011) discriminates between three nested levels of dynamic systemic organisation which he terms 'homeodynamics,' 'morphodynamics,' and 'teleodynamics' respectively. 'Autogenesis' primarily occurs in 'teleodynamic' systems and refers to the fact that these systems typically trend towards synergetic self-stabilisation; the road towards a stable system-state thereby depends on previous system-states. This is what Deacon refers to as 'reciprocal catalysis' and *self-catalytic* functions are indeed critical to most 'autogenetic' accounts.

[128] 'Organicism' and 'mechanism' trend towards opposing extremes here: whereas 'organicists' usually gravitate towards the idea that wholes are, to a large extent at least, *self-movers*, 'mechanists,' at least representatives of 'consolidated' variants of the theory, regularly presume that the world contains entities that serve as "movers" and such that 'are moved' and that an ultimate explanation requires to specify *first-mover(s)*. This juxtaposition of 'self-mover' and 'first-mover' elucidates much of the interpretive friction between the two 'integrative' world theories.

[129] It may be helpful to distinguish here between 'inner structure' as a category of 'mechanism' (and to a certain degree of 'formism') and 'deep structure' as a category of 'organicism.' While the concept of 'inner structure' conjures an *ontological dependency*, that is, the circumstance that most worldly entities need to be explained by more basic, yet distinct entities, proponents of 'deep structure' regard this construal as an unnecessary complication of factuality bespeaking of a problematic interpretive leap. Advocates of 'deep structure' typically hold that most worldly entities have to be explained by illuminating their existential and developmental logic, i.e., by revealing the co-constraining nature of the entities' various layers of organisation – the paradigm here is *ontological auto-nomy*. 'Inner structure' propositions thus focus on the structure of the world at large and promote the investigation of *external relatedness*, whereas 'deep structure' assertions concentrate on the structure of particular objects/phenomena and the examination of *internal relatedness*. Ultimately, this is the main difference between 'getting to the bottom of things' ('mechanism'/'formism') and 'getting to the top of things' ('organicism'). From the perspective of the practice of research, the analysis of 'deep structure' is often facilitated by the 'ideal-type method' (cf. Gerhard 2001) and, consequently, makes regular use of *idealisation* and *abstraction* as interpretive operations. Needless to say, this predisposition provides some of the reasons why 'non-organicists' are quick to qualify 'organicism' as a 'speculative' and ultimately 'subjective' research endeavour.

crucial for many organicistic approaches and further contributes to the perceived complexity of organicistic reasoning.

The guiding schools of thought for organicism are *objective idealism*, *process philosophy,* and some branches of *philosophy of life*. As Pepper himself (1942: 141f.) posits, organicism's historical progenitors are 'German' and 'British idealism' with type-scholars such as Hegel, Schelling, Bosanquet, and Bradley. Arguably, this list has to be extended to acknowledge the influence of eminent figures such as von Uexküll, Whitehead, and Bergson, and of intellectual movements such as French 'vitalism' and 'spiritualism.'[130] Organicism has further roots in non-positivistic branches of natural philosophy and notably draws on 'semiotics,' 'phenomenology,' 'structuralism,' 'dialectic materialism' ('Marxism'), and 'post-anthropological philosophy.' The latter represents a coalescence of various influential strands in French philosophy which – via Canguilhem, Bachelard, Souriau, Simondon, Deleuze, and others – have contributed to the proliferation of *radical ontological theorising* in the wake of Descola, Latour, and Stengers. This relatively recent current of thought emphasises radical differences in how distinct kinds of phenomena *behave* in time. Another associated ideational source for organicism is 'cybernetics' in the wake of Wiener, von Bertalanffy, von Neumann, von Foerster, and Bateson, to name only some of the key players.[131] Similarly, the legacy of French socio-ethnology in the wake of Durkheim, Mauss, and Testart – exemplified by the concept of « *morphologie sociale* » – has profoundly shaped some organicistic concepts and ideas.[132]

Organicism naturally promotes 'holistic' theories of evolution, often grounded in 'non-genecentric' perspectives, tends to retain 'Neo-Lamarckian' elements, and stresses the need to endorse the 'creative' moment of evolutionary processes – processes that are regarded to be only imperfectly captured by the dominant 'Neo-Darwinian' paradigm.[133] Organicistic theories of evolution typically do not foreground 'competition,' which organicism takes for granted (as an exemplification of 'conflict' and 'contradiciton'), but instead place primary emphasis on *cooperation* and the *horizontal coordination* among the objects of evolution. Partly for these reasons, organicism turns out to be rather insignificant for modern evolutionary biology and the life sciences at large. Most of these disciplines perpetuate 'mechanistic' understandings of both evolution and life (cf. Allen 2005).

Organicism is appealing because it responds to the intuition that objects, when they travel through time, transform in a rule-based, i.e., non-randomised manner, and that later stages of this transformation can be explained by earlier stages. In addition, organicistic explanations are *economic* in an important sense: they have great potential for *unification* which is often regarded to be an important explanatory virtue (cf. e.g., Kitcher 1981; Schurz 1999). Complementarily, organicism promises to reveal and describe kinds of relationships that are otherwise quickly overlooked – mainly structure-giving linkages that are 'distributed' on the temporal plane but nonetheless appear to modulate the 'genesis' of observable phenomena (i.e., emergent properties, developmental schemata, and domain-specific rule-sets).

Yet, organicistic thought is often seen as potentially self-contradictory in its attempt to resolve the relationship between the 'absolute' and its 'fragments' (cf. Pepper 1942: 314). Moreover, 'non-organicists' typically reject what they perceive as organicism's latent 'essentialism.' Organicism is also often regarded to be inconsistent with modern evolutionary theory, in particular Darwinian evolution as it has been formulated after the 'Modern-' and 'Extended Synthesis.' Organcistic evolution, as we have seen, is often imbued with Bergsonian 'creativity;' this Bergsonian impetus entails the idea that time is *qualitative* and *subjective* (i.e., object-specific) in non-trivial ways – a view that clashes with the 'dimensional' interpretation of time favoured by both 'formism' and 'mechanism.' In fact, organicism's specific treatment of time is one of the central reasons why it is often so fiercely combatted. The organicistic conception of time, for instance, threatens to undermine the 'actualistic' conviction that the present provides a viable frame of reference for knowing both past and future: in the view of organicists, the present can never be 'more than a sampler of the present order.' Another reason why organi-

[130] Some of these cognitive trends are now being amalgamated under the label 'panpsychism' (cf. e.g., Skrbina 2005; Goff et al. 2017).
[131] See Johnson (2014) for the specific and highly systematic discourse on 'cybernetics' in French intellectual culture.
[132] Cf. e.g., Barberies (2003) and Dunn (2016: 11-31).
[133] A recent example of this genre of approaches is Corning's *Holistic Darwinism: Synergy, Cybernetics, and the Bioeconomics of Evolution* (2005). This alternative perspective on evolution is explicitly presented as an attack on 'Neo-Darwinism' and highlights the 'multi-level nature' of evolution, 'group selection,' 'symbiosis,' 'cooperation,' 'developmental dynamics,' 'genotype-phenotype interdependencies,' 'hierarchy theory,' 'systems biology,' and 'autocatalysis' (cf. *ibid.*: 1-7).

cism is looked upon sceptically is because it fosters theories of *directed evolution* clashing with the received view that evolutionary processes are non-directed.[134] 'Non-organicists' regularly lament organicism's supposed inability to deflect what is known as the 'teleological fallacy.'

2.5 **Affinities and trade-offs between world hypotheses**

The general exposition of the structure of the four relatively adequate world hypotheses has already demonstrated that they organise themselves into two groups of two. The elucidation has shown that important affinities and trade-offs between these hypotheses are observable and that these can be clarified relative to the structural polarities 'analytic'-'synthetic' and 'dispersive'-'integrative.' I have suggested that the first polarity is typically interpreted 'antithetically,' whereas the second polarity tends to support cognitive complementarity fostering eclectic tendencies. As we have seen, from this general architecture of world hypotheses it follows that there should be a strong trend for 'formism' and 'mechanism' to mingle, to borrow from each other, and to share similar discursive spaces; and the same should apply for 'contextualism' and 'organicism.' What I will show in this section is that from this general organisation of world theories four other interpretive polarities result: (i) the gap between *Appearance and Reality*; (ii) the rift between 'externalism' and 'internalism'; (iii) the clash between 'dialectic-dialogical' and 'formal-logical' schemes of argumentation; and (iv) the disparity between 'qualitative-conceptual' and 'quantitative-statistical' strategies of data visualisation. I argue that these polarities help illuminating some of the more tangible research consequences of world hypotheses – consequences which clearly leave their mark on lithic research in Palaeolithic archaeology and should prove useful for understanding the stakes of the French-Anglophone divide.

The problem of *Appearance and Reality* is only acknowledged by the 'integrative' world theories since only these are primarily concerned with advancing 'precision' and thus constantly strive to explain away or unify the facts they register (cf. Pepper 1942: 145). The mere idea that there is a 'phenomenal' layer of reality that only shows the surface of what actually is embodies a prototypical conviction of world hypotheses that champion strong determinacy – 'mechanism' and 'organicism.' To negotiate the 'appearance'-'reality' gap is a structural feature only of world theories that conceive of 'order' as *categorical*. These 'integrative' theories regard the directly perceivable layers of reality as potentially 'misleading;' in their own words, they are interested primarily in how the world truly *is* rather than how it is *perceived*.[135] Although adherents of this view openly debate how one can precede from what merely 'appears' to be to what actually 'is,' they would generally agree that there must be 'more' to the world than can be experienced – there must be something, in other words, that explains why one perceives what one perceives.[136]

The 'appearance'-'reality' gap has its origin in this general scepticism about the cognitive value of unfiltered direct perception, which is proper to the 'integrative' theories. Its systematisation typically leads to the distinction between 'observables' and 'unobservables' and the latter's theorisation and characterisation.[137] Because 'integrative' world theories presume that 'reality' is not easily accessible and therefore conceive of it as partly 'unobservable' or at least as 'difficult-to-observe,' they face great

[134] It has to be stressed here, however, that this issue is often confused in popular culture and popular science alike. The 'teleological' inclination of 'organicism' (see *supra*) must not be confused with the idea that evolution is necessarily goal-directed, let alone that this goal is pre-fixed or pre-determined in any way. Organicism is merely inclined to posit that evolution creates 'directed' pathways of becoming – a much less controversial claim. This 'directedness' of evolution is to be distinguished from 'goal-directed' evolution. Organicistic evolution, in other words, can be 'directed' without being 'goal-directed'; organicistic 'teleology' is often misrepresented by 'non-organicists' to this particular effect.

[135] The point here is that this distinction is systematised and consequentially developed only in the 'integrative' theories; in 'contextualism,' for example, the distinction between 'appearance' and 'reality' makes only little sense since the question is not what is 'real' and what is not, but rather what are the relevant contexts of reality that arrange and give shape to reality in its totality.

[136] The distinction between 'reality' and 'appearance' can therefore lead to 'objectivist' or 'subjectivist' systematisations: the 'objectivist' interpretation claims that perception is constituted by structural features of the outside world which exist independently of the subjects perceiving them; the 'subjectivist' reading posits that perception is brought into existence by structural features of the perceiving subjects and can therefore never reach out entirely to an outside subject-independent world. Needless to say, in practice we often encounter a mixture of both positions but in specific articulations. 'Mechanists,' for example, would typically defend the 'objectivist' reading and content that some perception is indeed 'subjective' and researchers must therefore strive to identify and eliminate such 'biases' – as one can easily see, this entire talk makes only sense if one accepts the 'reality'-'appearance' gap as a structural feature of the world.

[137] A classic example for a 'mechanistic' conception of key 'unobservables' is 'atoms.'

difficulties of convincing each other about the most promising 'unobservables.' This core question – what makes up 'reality' – is therefore a structural divider among 'integrative' world theories; they combat and reject each other mainly because of this question. Whereas 'mechanists' tend to believe that all phenomena are caused or constituted by the core features of the world's 'inner structure,' 'organicists' typically hold that there can be no such structure independently of the phenomena under consideration; according to them, it is the 'deep structure' of the phenomena themselves which consequently helps to explain their 'appearances.'[138] This issue is largely irresolvable. Shared 'integrativity' therefore turns out to be a locus of conceptual disparity rather than solidarity.

'Dispersive' world theories, conversely, are not committed to the idea that the world can be broken down into 'appearance' and 'reality;' they are not so much interested in providing ultimate and ideally singular reasons for why certain phenomena can be found in the world, but rather try to take these phenomena seriously and to understand how the totality of facts is organised in relation to them. The recourse to something beyond the 'phenomenal' world thus appears almost 'mystical' to them – this is even true for 'formistic' theories since their category of 'subsistence' denotes, strictly speaking, merely the 'flip side' of what is defined as 'existence,' the point is not, therefore, to reduce 'existence' to 'subsistence.'[139] The 'dispersive' theories combat each other with similar stubbornness as the 'integrative' theories but their conflict is about how to tackle and not to get lost in the latitudinal richness of evidence. Shared 'dispersivity' hence also tends to be a locus of conceptual divergence rather than convergence.

The second polarity is between 'internalism' and 'externalism,' understood as regulative ideas of knowledge formation.[140] This polarity is another result of how evidence tends to be marshalled and explained by the four relatively adequate world hypotheses. It turns out that 'formism' and 'mechanism' enact a gravitational pull towards interpretive 'externalism,' whereas 'contextualism' and 'organicism' generally favour interpretive 'internalism.' The division hence reproduces the 'analytic'-'synthetic' antagonism but is not an inevitable consequence of it. On a general level, however, the polarity is indeed foreshadowed by the fact that 'analytic' theories carve out parts and analyse their composition, which in practice usually means to study how parts are *externally* related. 'Synthetic' theories concentrate on the delineation of wholes and analyse the effects of the latter on the constitution of parts, which typically implies that parts need to be examined in terms of their framing through other parts of the same whole (i.e., the whole is studied in terms of its *internal* relatedness). This contrast is important and resonates with the types of cognitive criticism promoted by the two groups of world theories (see *infra*).

In 'formism,' facts are classified and arranged according to 'characters,' 'traits' and/or 'types' before they are ultimately examined in light of *other* classes of 'characters,' 'traits' and/or 'types;' providing an explanatory account thus typically means to invoke one or more part-categories of the world that are *external* to the category under consideration but share relevant features with it.[141] 'Mechanistic' world theories generally radicalise this 'externalist' strategy of explanation by wrestling with the 'problem of transition.' This problem is, as we have seen, a consequence of 'mechanism's' dualistic architecture made up by its 'primary' and 'secondary' categories. Since the 'primary' categories are typically identified as the features of the world that 'constitute' or 'cause' the features of the world encapsulated by the 'secondary' categories, 'mechanism' also tends to explain by means of a categorical 'else.' This becomes perhaps clearest when the theory compartmentalises reality into dif-

[138] This is the irony of 'integrative' world hypotheses: even though they agree that the 'phenomenal' can be misleading and that *unobservables* are the key for understanding the world, they treat each other with hostility because of that; the fact that they have to face such unobservables and to specify them regularly leads the two theories to heavily disagree on what the relevant unobservables are.

[139] In fact, the whole point is precisely that 'subsistence' cannot be reduced without loss to the realm of 'concrete existence' – according to 'formism,' whatever *subsists* cannot fully be particularised.

[140] I am adopting a rather unconventional understanding of the polarity between 'internalism' and 'externalism' here. Usually these terms are employed to indicate whether knowledge is thought to depend primarily on factors internal or external to the knowing subject (cf. Pappas 2017). In contrast, I am not concerned with subjects, but with the entities/phenomena to be explained or understood. Interpretive 'internalism,' then, is the view that in order to elucidate any such entity, one needs to relate its parts to some aspects external to the entity; interpretive 'externalism,' by contrast, would posit that understanding the entity mainly depends on our ability to reconstruct how the entity is internally constructed.

[141] Needless to say, 'externalism' here is often interpreted according to the 'theory of sets' and therefore not always involves a transition from one object of analysis to another one – a characteristic of a particular woman might for example indeed by explained by another characteristic of the same woman. The *problem of transition* – defining for 'mechanism' – is a non-problem in 'formism' but the general explanatory strategy of the latter is nevertheless 'externalist.'

ferent layers or domains; the 'chains of causality' which are then typically conjured to derive the characteristics of each layer or domain from another layer or domain give a strong voice to this general predisposition – a predisposition which is already echoed in the basic 'push-and-pull' intuition of 'mechanism.'

'Contextualists,' conversely, try to *internally* relate the facts they hope to explain by arranging them into their wider context; each fact is made sense of by determining its position relative to the 'quality' and 'texture' of its context. Since each context remains peerless insofar as the categories of 'novelty' and 'change' apply, 'contextualistic' theories cannot, by definition, externally relate different contexts to expound them; 'contextualism' therefore relies primarily on identifying and mapping *context-internal relationships*, especially 'interpenetrations' – and only these are considered the key bearers of refined knowledge. 'Organicism,' by entrusting much of its explanatory work to the conception of *self-moving* spatiotemporal structures, naturally mirrors the same 'internalist' preoccupation. Although 'organicistic' theories are also fed by a dualistic structure of categories, both the 'progressive' and 'ideal' categories reference the *same* object matter, a unified structural whole distributed in time and space – the identification and interpretation of the 'progressive' categories in light of the 'ideal' categories, and *vice versa*, thus helps to order isolated facts *internally*, to connect them 'genetically' (temporally), and to discard those that cannot be considered internal to the phenomenon in question – a classic 'internalist' manoeuvre.

The third polarity concerns the commonly favoured mode of argumentation. A distinction is to be made here between two grand families of argument: 'dialectic-dialogical' and 'formal-logical' modes of argumentation. This distinction not only touches upon the type of argument considered to be useful in order to advance inquiry or to reject knowledge claims, but also on how these arguments are to be related and mobilised. It obviously cannot be overrated how important argumentation in science is. If differences in world theory commitment can be shown to animate basic differences in how scientific arguments are construed, the actual consequences for varying realities of research and their fruits of knowledge can be expected to be tremendous. Generally speaking, the two basic views of argument that are relevant here broadly map onto the dichotomy between 'analytic' and 'synthetic' world theories and appear to be the result of how the respective theories police part-whole relations.[142]

The first view, drawing on a 'dialectic-dialogical' notion of argument, regards argumentation as an 'intricate,' 'complex,' and 'multi-layered' exchange of *pros* and *cons* for evaluating a given state of affairs (cf. Stutt and Shennan 1990: 768). This view explicitly opposes the idea that argument is nothing more than a "one-shot demonstration that settles the questions once and for all" (cf. Blair and Johnson 1987: 51). Stutt and Shennan (1990) have called this stance 'interactionist' since nothing is regarded to be 'fixed' or 'secure.' Arguments are essentially shifting discursive formations, constantly in need of revision and re-adjustment. The structure of argument-making and -progression is thus typically 'multi-stranded' and even 'multi-directional,' often appears to be 'cyclical,' and tends to take 'conversational' shape.[143] This also means that insight is not only generated by argumentative outcomes, but emerges from the 'dialogical' process of argumentation itself.[144] The archetype for this type of argument are the *Platonic Dialogues*.

The second view, drawing on a 'formal-logical' notion of argument, envisions argumentation mainly as a 'structured body of propositions' with predefined rule-sets for how to precede from one step to the next; this essentially conforms to what Stutt and Shennan (1990: 768) have called the 'prescriptive' stance of argument. This stance tends to rely on the formalised languages of symbolic logic and mathematics as structure-giving elements – argument is primarily defined as 'logic in use' (cf. Toulmin 1958). Therefore, argument ought to be a maximally 'transparent' and unidirectional process, in which the premises and the operations to elevate the premises into a hypothesis that can be plainly accepted or rejected are clearly laid out.[145] The regulative idea is that of the *automaton* – given a defined rule set and a specified argumentative input, the argumentative conclusion should be a some-

---

[142] For archaeology, readers are referred to Stutt and Shennan's treatment of the topic in *The Nature of Archaeological Arguments* (1990).
[143] This does not mean that argument is necessarily 'circular' in the logical sense, as some of its opponents want to have it.
[144] This implies, in other words, that one cannot tell before one delves into an argument which aspect of the argumentation will be most illuminating – in fact, the main point is that the result of the argument might be rather un-sensational, but part of the *exchange* leading to this point may be extremely illuminating.
[145] They are indeed often explicitly *defined* at the start of inquiry – this can translate into the organisational structure of a study, so that there is a specific section devoted to this task.

what ‘automatic’ outcome.[146] Argument strives to be as ‘demonstrative’ as possible and is primarily oriented towards its achievements. The archetype for this mode of argumentation is the *modus ponens* – argument is typically modelled on ‘syllogistic’ reasoning.

Pepper’s world hypotheses theory enables us to explain why it is so difficult, if not impossible, to combine these two visions of argument. The reason seems to be that the two grand families of argument are well-adapted to respond to the preconceived structure of the world advocated by the ‘analytic’ and ‘synthetic’ world theories: ‘formal-logical’ modes of argument take it for granted that the world is an ‘incremental’ and ‘compositional’ entity and therefore ought to be studied as such; ‘dialectic-dialogical’ modes of argument, by contrast, tackle the world primarily as a ‘configurational’ entity equipped with a residual ‘wholeness’ never to be fully resolved in its parts and therefore to be studied as such. This is another example for how structuring the totality of evidence feeds into the normativity of inquiry. It is at least not surprising from this perspective that ‘formism’ and ‘mechanism’ share the same general conception of argument, and that ‘contextualism’ and ‘organicism’ do the same. We will see in the next section that these modes of argumentation also neatly articulate with the promoted theories of ‘cognitive criticism’ (conditions of truth).

The fourth polarity brings into focus a somewhat peculiar domain of scientific cognition – ‘visualisation.’ In general terms, all research of course faces the basic problem of ‘making visible’ what it finds, proposes, and/or ponders upon. Apart from strictly ‘textual’ strategies of explicating knowledge contents, scientific inquiry can also draw on ‘pictorial’ strategies of explication. These are cognitive instruments in their own right and can be used to bolster knowledge claims, to persuade peers of their significance, and/or to motivate entirely novel interpretations – non-textual visualisation thus certainly play an important role in the rhetorics of science. It is more than likely that there is a give and take between certain ‘textual’ strategies and certain ‘pictorial’ strategies in processes of knowledge formation.[147] Moreover, the images and pictures mobilised during research should reflect the needs and strengths of the guiding world theories. How each world theory organises its evidence and cognitively ‘digests’ it is therefore expected to have a strong bearing on the types of visualisation it promotes and develops.[148]

The visual needs and potentials of the four relatively adequate world hypotheses can be theorised relative to the primary structural polarities ‘analytic’-‘synthetic’ and ‘dispersive’-‘integrative.’ The resulting visual signatures are not surprising given what has already been said before. For the divide between ‘analytic’ and ‘synthetic’ theories it is again the differential emphasis on parts and wholes that turns out to be cognitively decisive. Whereas the ‘analytic’ theories – ‘formism’ and ‘mechanism’ – focus on depicting parts and how they compare to other parts, the ‘synthetic’ theories – ‘contextualism’ and ‘organicism’ – attempt to visually ‘mould’ the wholes they seek to reconstruct and understand. ‘Synthetic’ visualisation entails the specification of which parts belong to which wholes and in what way(s). The former, in comparison, encourages the mobilisation of visual techniques of ‘atomistic’ pattern-recognition and correlative comparison. Quantitative graphs with two or more axes of juxtaposition are consequently a hallmark of ‘analytic’ visualisation. ‘Synthetic’ visualisation strategies, by contrast, generally tend to focus on the more qualitative aspects of part-whole articulations; the images and graphs they encourage favour more ‘abstract’ and ‘conceptual’ depictions – the visualised links between parts and between parts and wholes are often of an ‘idealised’ and highly ‘orchestrated’ nature. Thus, ‘schematic’ reasoning, often supported by ideal-typical practices of making visible, is expected to form a hallmark of ‘synthetic’ visualisation.

The differences between ‘dispersive’ and ‘integrative’ theories are slightly more subtle. ‘Dispersive’ visualisation strategies seem to gravitate towards two extremes: either they motivate a in comparison to ‘integrative’ strategies disproportionally high number of graphs, tables, and/or drawings, or

[146] In the view of many proponents of ‘formal-logical’ argumentation, this is why this mode supports an ‘objectivist’ conception of science. The idea is that arguments are only convincing, firstly, if their authority can be uphold independently of the subjects who advance them and, secondly, if they can be safely and reliably reproduced by different subjects. What is interesting about this is that ‘mechanists’ will have natural advantage here because they can simply draw on their root metaphor to refine the directed and quasi-automatic enchainment of arguments to reach the inevitable conclusion.

[147] We can therefore say that each ‘style of reasoning’ includes one or more ‘style of visualisation;’ whether and how these (also in numerical terms) relate to one another, however, remains an open question and can only be answered empirically, by examining their relationship in concrete case studies.

[148] If correct, this would be a good example for the *enabling* propensity of world hypotheses, their ability to literally render the world *portrayable* in particular ways.

they try to condense the richness of their account into a single exceptionally 'dense' or 'complicated' diagram which illustrates how different facts and categories of reality relate to each other. The goal of these depictions is to visually 'secure' this richness rather than to break it down or to resolve it. 'Integrative' visualisation also gravitates towards 'essentialisation' and 'reduction' in order to highlight those features which are seen as key to explain the examined phenomena. These 'condensed' graphs typically emphasise *directionalities of determination* – a classic example is a flowchart. Another regular symptom of 'integrativity' in visual cognition is 'generalisation,' which typically results in rather generic representations of items and processes, with only minimal resemblance to the actual objects of study (e.g., artefacts).

2.6 **The problem of corroborating knowledge claims**

World hypotheses involve propositions about how to corroborate – that is, to confirm, validate, and/or reject – dispositional knowledge claims (Pepper 1942: 150). Since world hypotheses are unrestricted hypotheses about the world, criteria for scientific 'validity,' 'truth,' and 'plausibility' turn out to be a part of the hypotheses themselves. In fact, world hypotheses tend to be somewhat dogmatic in how they criticise and secure the knowledge they advance. Because world hypotheses are strictly autonomous, it follows that each hypothesis is obligated to a particular *conception of truth* – each theory supports its own 'theory of cognitive criticism' (*ibid.*: 149). In other words: each of the theories solves the problem of corroborating knowledge claims differently and in relation to its own categorical architecture. The theory of cognitive criticism respectively supported is hence an upshot of the accepted root metaphor and specifies how cognitive adequacy can be maintained and monitored. From the perspective of Pepper's world hypotheses theory, it is thus no surprise that 'truth' and 'knowledge corroboration' remain to be perennial problems for philosophy and science alike; these question can simply not be decided upon without pre-casting the world into coherent and relatively adequate world hypotheses. Accordingly, the 'classic' theories of truth are simply reflections of the cognitive tendencies defined by the most potent world theories.

The specific theory of cognitive criticism vindicated by each world theory is hence a prominent marker of the theory and its cognitive peculiarity. In Pepper's (1942: 150) own words, "the logic of each [world] theory [...] follows from its theory of truth." It is for this reason that problems of scientific 'veracity' and 'certainty' deserve special attention here. Diverging conceptions of truth allow us to retrace diverging conceptions of 'objectivity' and thereby help to clarify that *each* theory is generally capable of enacting 'intersubjective' standards of knowledge corroboration. Each theory nonetheless seeks to ensure the *relative objectivity* of its claims according to its own terms; 'non-objectivity' allegations by other theories are therefore typically normatively incrusted and merely confirm that world theories tend to be built on diverging notions of 'objectivity.'[149] This interlocking of concepts of 'truth' and 'objectivity' also elucidates why even definitions of 'argument' and/or 'data' usually differ between world theories. We can in fact say that different theories of cognitive criticism *depend* on different ways of devising data and constructing arguments in order to safeguard the cognitive value of their world hypotheses.

In what follows, I will shortly expose the four general theories of truth that correspond to the four relatively adequate world theories. I will concentrate on the relative differences between these theories in order to clarify their cognitive significance; these differences have a direct bearing on how empirical evidence can be handled, how data is generally interpreted, and what types of knowledge claims are typically supported. The exposition will help to derive a clearer understanding of the cognitive distinctiveness of each of the four world hypotheses. I begin with the 'analytic' theories and show that 'formism' relies on a correspondence theory of truth, whereas 'mechanism' places its confidence in a causal-adjustment theory of truth; I then turn to the 'synthetic' theories and demonstrate that 'contextualism' harbours an operational theory of truth, whereas 'organicism' turns out to be the prime advocate of a coherence theory of truth. The point is not so much that proponents of the different world theories are forced to accept the appropriate theories of cognitive criticism, but rather that they

[149] It cannot be overemphasised here that *objectivity*, as a consequence, also belongs to the 'internal' categories of world hypotheses can therefore not be invoked to reject any other competing hypothesis.

will be naturally attracted by these theories if they wish to advance and refine their cognitive enterprise.[150]

2.6.1 *Correspondence as the truthmaker in formism*

The basic principle of knowledge corroboration in formism is *correspondence* and formists, as a consequence, strongly gravitate towards correspondence theories of truth (cf. e.g., Fumerton 2002). These theories generally posit that in order to secure scientific veracity one must ensure that knowledge claims correspond to the facts in the world that they address (cf. Sher 2013). This, of course, is an archaic idea in philosophy. A classic formulation can for example be found in the work of Bertrand Russell (1971 [1912]: 129) who advocated the notion that "[...] a belief is true when there is a corresponding fact and is false if there is no corresponding fact." The basic intuition is that there ought to be a structural similarity between the knowledge claim and its facts – an intuition that derives from the formistic root metaphor of 'similarity' (cf. Pepper 1942: 180). The crux of correspondence conceptions of truth is to determine what the relevant type of similarity is and how the relation of correspondence between knowledge and facts can be guaranteed (e.g., David 1994).

This leads to a distinction between 'truthmakers' and 'truthbearers:' the former define the linkage between knowledge claims and the facts they concern, while the latter specify the features of the world which can legislate about the weight and cognitive significance of these relations (cf. e.g., Armstrong 2004; Marian 2016). The truthbearers of correspondence theories are parts of the world – what formism identifies as 'particulars,' 'characters,' and/or 'ties' (cf. **Box 6**) – and these, in turn, have variously been signified as facts, traits, attributes, states of affaires, conditions, situations, events, objects, sequences of objects, sets, properties and/or tropes (Marian 2016). Acclaimed formistic truthmakers that establish how these truthbearers ought to compare to knowledge claims are for example conformity, congruence, agreement, accordance, copying, picturing, signification, representation, reference and/or satisfaction (*idem*). To find the most pregnant truthbearers and their most promising truthmakers keeps formism busy and constitutes an ongoing area of debate and refinement. What cannot be disputed by formists, however, is that scientific truth essentially consists of a bipartite relation and it is this relation that needs to be evaluated in order to judge knowledge claims.

That this bivalent relation is interpreted through the root metaphor of 'similarity' has important consequences for how the 'veracity' of knowledge candidates can practically be assessed. The basic strategy of comparing truthbearers with knowledge claims and to analyse the relation between the two through the lens of the envisaged truthmakers predisposes this theory of cognitive criticism to scrutinise the *relative strength* of correspondence relations, which, in turn, lends credence to methodological procedures which enable an 'analytic' assessment of *degrees* of (dis-)similarity (cf. Pepper 1942: 180f.); this greatly animates correspondence theories of truth to make use of quantitative-statistical methods to reliably measure 'truth-making' and to compare its strength across competing knowledge claims. This is the meaning of operational hypothesis-testing in formism – it is nothing less than an attempt to establish the relative (dis-)similarity between the hypothesis and the facts it covers. As a general corroborative strategy, it also explains why formists often ground their examination of evidence on continuous variables – continuous variables help to analyse similarity and correlation and hence to untangle 'truth-making' correspondences.

Another consequence of the bipartite nature of knowledge corroboration in formism is that knowledge claims tend to be 'descriptive.' A hypothesis said to be 'valid' or 'applicable' is a hypothesis whose assertive content resembles what it talks about. As Pepper (1942: 181) himself admits: "[...] we may very simply define truth as the degree of similarity which a description has to its object of reference." Formistic explanations therefore often aim to reproduce the factual characteristics of their object matter (*idem*). This typically requires the transfer of evidence into an independent data format, so that the form-based characteristics – 'characters' and 'ties' – of the examined parts can be more effectively analysed, compared, and described. The construction of 'classes' and/or 'types' and their locali-

[150] We can therefore say that cognitive inadequacies may arise when scholars indulge into a cognitive project defined by a world theory but deploy an inconsistent theory of 'cognitive criticism' to advance it. The resulting inconsistencies threaten to collapse the accepted world hypotheses and thereby endanger the 'adequacy' of its knowledge claims. Nonetheless, practiced science may be stuffed with cognitive confusions of this sort.

sation in patterns may thus already count as a good description. In this way, correspondence can effectively be monitored by analysing the participation of truthbearers in the 'relations' defined by the truthmakers – e.g., 'regularities,' 'norms,' and/or 'laws' – so that searching for correlations and co-variations emerges as a key operation in formistic knowledge corroboration;[151] taxonomies, systematics, and form-based typologies are important cognitive instruments precisely because they facilitate the organisation of the totality of evidence, which is often a crucial precondition to check for factual correspondence(s). The resulting groups, sets, and/or clusters of facts can then simply be compared to the available knowledge claims in order to determine whether there is a structural match or not.

Since formism prioritises the analysis of 'participation' – that is, how its truthbearers contribute to patterns – 'induction' tends to be the central method of cognitive criticism. According to Pepper (1942: 182), formists typically recognise two types of induction: (i) inductions that yield descriptions of 'empirical uniformities,' and (ii) inductions that yield descriptions of 'laws.' The former concern patterns in 'concrete reality' that do not exist by necessity – patterns which are contingent but nonetheless reliable truth indicators. The second type concerns patterns that are necessary – patterns that exemplify a general 'law.' This general discrimination leads to the formistic distinction between 'historic' and 'scientific' –between historic truth and scientific truth (*ibid.*: 182f.).[152] Hence, empirical uniformities are typically identified as being merely of historical significance; yet, in the spirit of formism's inherent 'dispersivity,' they are nevertheless regarded to be 'real' and informative about the world. Having said this, since empirical uniformities derive from contingent facts, they are often considered to be sources of 'half-truths.' According to formistic logic, notwithstanding, the cumulative force of these 'half-truths' allows for the approximation of scientific truth and the necessary structure of the world in the long run (*ibid.*: 183f.). This 'graduation' of varying truth values is anticipated by the work of Francis Bacon, who conceptualised science as an ongoing process of climbing the ladder of knowledge: starting from all of the available facts, one would first have to reach the 'middle-principles' before ultimately proceeding to the highest and 'purest' ones (cf. Carrier 2016: 16). The interesting issue here is that formism apparently has to counterbalance the relative 'sameness' of its evidence – a result of its 'dispersivity' – with a pronounced hierarchy of knowledge.[153]

2.6.2 *Causality as the truthmaker in mechanism*

The basic principle of knowledge corroboration in mechanism is *causal-adjustment*; mechanists, therefore, are typically proponents of what Pepper (1942: 228) terms 'causal-adjustment theory of truth.' The key concept of the theory is 'causality' broadly defined, i.e. including weaker principles of determination such as 'constitution' (cf. Williamson 2011). More generally, causality is interpreted as a determinative process distinguished by its 'specifity of response' (*ibid.*: 226).[154] There must always be a *reason* for why a particular phenomenon or behaviour can be observed – that is, there must be some-

[151] We can adopt Nancy Cartwright's (2004) differentiation between two types of scientifically relevant laws here: 'laws of association' and 'causal laws.' The former are defined by what Pepper would call 'participation.' Moreover, these 'laws' are causally neutral – although this doesn't mean that the authors who advance them reject causality as an important principle to shape reality – and typically tell us how often and under which conditions the quantities and qualities of parts are 'co-associated' (*ibid.*: 419). Following Cartwright (*idem*), one might say that 'laws of association,' in contrast to 'causal laws,' mainly target the structure of co-occurrence(s) itself and try to capture this structure, but they rarely provide a comprehensive account of what 'makes it happen.' The 'laws' of 'formism' can thus be said to primarily consist of such 'laws of association.'

[152] The important point here is that 'formism' requires both historic and scientific truth in order to picture the world comprehensively and adequately; the two types of knowledge thus complement each other, even though they may of course interfere at times. This is why the rejection of historic truth as a basis for science threatens to collapse the theory, and often marks the transition to 'mechanism' and its causal-adjustment theory of truth (see *infra*). The perhaps best example from the younger history of archaeology for such a process is the well-known critique of Lewis Binford and his followers on what they perceived as American 'Historical' Archaeology – a type of archaeology they wanted to supplant with their own 'New' Archaeology, built on more robust 'scientific' foundations (cf. Binford and Sabloff 1982; Clark 2002: Table 1). The rhetoric and conceptual importance of Binford's (1968) distinction between 'history' and 'science' is a clear indication for his attack on formistic logic and his determination to usher a more 'mechanistic' type of research in American archaeology (cf. Trigger 2007: 400f.).

[153] We will see in the following that this is a trade-off proper to 'formism' and that the other credible world theories make other 'deals' in this regard. ['sameness of evidence' simply means that there is no structural incentive for the theory to rank and/or weight its evidence before processing it]

[154] The principle of 'cause-and-effect' has been systematised by David Hume [1711-1776] ('theory of regularity') and was subsequently refined by John Stuart Mill [1806-1873], who proposed three cognitive strategies to avoid falling prey to causal fallacies (cf. Carrier 2006: 27-35).

thing in the world which has 'triggered' it.[155] Any grounds offered, moreover, must be *specific* enough to apply to what one seeks to explain (e.g., Clark 1963).[156] For causal theories of truth this requirement of 'specifity' ushers an important response to the so-called 'Gettier problem,' according to which knowledge about the world is constantly threatened to be only accidentally true (cf. Sturgeon 1992);[157] this general difficulty prompts us to reconsider how knowledge can be *secured* and thereby shifts the attention to the *relevance* of the offered explanations.[158] In order to avoid the 'Gettier problem,' causal theories typically assert that knowledge claims are only approvable if one can demonstrate that a claim specifies the result(s) of the relevant causal connections which necessarily make it true. The concept of *necessity* is central here for it counters the possibility that knowledge becomes a mere question of 'lucky guessing' (cf. Pritchard 2015).[159] A now classic version of such a causal account of knowing has been offered by Alvin Goldman (1976: 361, original emphasis) who pioneered the idea that "[a] necessary condition of *S*'s knowing *p* is that [her/]his believing *p* be connected with *p* by a causal chain."[160] This notion of temporally well-structured 'chains of causation' is commonplace in mechanism and serves to devise the structure of reality (cf. Pepper 1942: 227);[161] it also incentivises mechanists to acknowledge a *ladder of causality* and to reject the 'formistic' ladder of knowledge as a symptom of superficial insight.

The 'specifity of response' principle, grounded in the mechanistic intuition of 'integrative' necessity,[162] gives rise to the recognition that 'prediction' must be a part of explanation itself. Prediction is cognitively esteemed because of the way causality is interpreted in mechanism – namely, as a consolidated field structure acting in highly specific and largely inevitable ways. It is for this reason that mechanism's causal adjustment-theory regards cognitive anticipation as a key epistemic virtue. Already Moritz Schlick (1932/33: 44) apodeictically noted: "[w]hat every scientist seeks, and seeks alone, are […] the rules which govern the connection of experiences, and by which alone they can be predicted." For mechanists, prediction is the most promising tool to unveil the *hidden structure of reality* and to pass the world of 'appearances.' Since one cannot observe the fabric of reality directly, one can only hypothetically devise it and compare its consequences with what one can, after all, observe directly. The analysis of these necessary consequences requires accepting some notion of 'causal laws' (*sensu* Cartwright 2004).[163]

As a note of caution, however, it is important to realise that mechanists are not the only ones who regard 'prediction' as a central aim of science; in 'formism,' too, the concept plays a certain role, but the ability to predict – i.e., to formulate theories and hypotheses entailing (logically or otherwise)

[155] The very idea that there are 'triggering' and 'non-triggering' facts is proper to 'mechanism' and, in 'consolidated' variants of the theory, typically leads to the identification of 'first movers' and causal 'singularities.'

[156] For more recent theories of causation which, to varying degrees, reflect conceptions of 'veracity' and 'truth' in practiced science, see e.g., Bigelow and Pargetter (1990), Heathcote (1989), Krajewski (1997), and Chakravartty (2005).

[157] The 'Gettier problem' was initially introduced to reveal an important weakness of traditional definitions of knowledge as 'justified true belief.' The problem illustrates that 'justification' and 'truth' are not sufficient to render a belief an item of knowledge; since a belief might be justified and true at the same time but only accidentally so, we need to ask how the belief was formed and whether it explains what it concerns (cf. Gettier 1963). This has provoked the issue of epistemic 'relevancy:' a belief can only be true if and only if the assertive claims it contains are relevant for the explanation of the contents of the belief. Causal theories of truth are consequently theories of knowledge which identify causality as the key 'relevance-maker,' some even hold it is the only reliable one that is available.

[158] In 'mechanistic' theories of cognitive criticism, a key concern is therefore to ensure that knowledge claims are *warranted*; and this, according to many 'mechanists,' can only be assured when some basic causal principles are invoked to show that the existence of the phenomena under consideration inevitably follows from them (cf. Pepper 1943: 363).

[159] 'Casual necessity' has variously been defined by 'mechanists.' Brian Skyrms (1980), for example, tries to capture the concept with his notion of 'invariance,' which he asserts to be a basic feature of a causally structured world.

[160] Although not specifically termed 'causal,' this general principle of determinative adjustment is consistent with Karl Popper's (1968) notion of 'conditional scientific predictions,' which he identified as characteristic for the natural sciences and their success.

[161] The concept of a 'causal chain' hence implies the 'mechanistic' theory of time, according to which time is to be regarded as an 'objective' and thus viewer-independent feature of the world; time is seen as relatively uniform (even though temporal relativity is of course granted under special conditions), well-ordered, and sequential. The classic view is that causes have to precede their effects although feedback effects are sometimes possible (these feedback effects are generally difficult to explain for 'mechanists').

[162] This is simply to say that mechanism of determination must have the capacity *to make a difference* in reality – this is what Jon Williamson (2011: 422) identifies as the classic 'difference-making theories' of causality.

[163] This is the perennial trouble of the 'empiricist' tradition in philosophy of science. Although 'logical empiricists' were generally sceptical about the idea that there is a hidden structure underneath the experiential surface of reality and tried to escape from its grip by an 'operationalist' manoeuvre – they argued that terms such as 'gene' or 'atom' merely help us to pick up complex patterns in reality – they could never uphold their agenda consistently, partly because of their insistence on 'prediction' and partly because of their sharp distinction between 'theory' and 'observation' in science (e.g., Hempel 1958, 1965; Oppenheim and Hempel 1948; cf. Godfrey-Smith 2003: 36f.).

certain observable regularities they were not originally concerned with – is tied there to quasi eternal principles of association – the faculty to 'predict' stems from the 'formistic' discovery of 'laws of association' (see 2.6.1). The world is considered of such an order that certain features turn out to be correlated and it is through the extrapolation of these patterned co-occurrences that 'formists' predict new patterns in *similar* or *analogous* constellations. Predictability, in this view, simply follows from the empirical determination of dependencies between observable phenonema.[164] Therefore, 'formistic' prediction is often about *structural* features of the world.[165] In mechanism, conversely, prediction makes use of the 'causal laws' outlined above. A key difference to 'formistic' prediction is that assertive novelty, an often-claimed necessary feature of valuable predictions, cannot be taken lightly by mechanists. Mechanistic prediction targets specific relationships that cannot be overly generalised, and that are certainly not 'eternal' in some relevant sense (cf. Pepper 1942: 220).[166] This notion of prediction is not grounded in empirical regularities *per se*, but rather exploits the circumstance that observable configurations of reality are affected by well-defined *mechanism(s)* in knowable ways. These 'effects' must not have been observed before, as long as one has understood the general principles of determination embodied by the mechanism(s) in question and the behaviour of the parts that make up the configuration. The mechanistic inevitability of outcomes is not an inevitability of forms but an inevitability of direct or indirect action between parts.

We should recall here that mechanism rests on a dualistic structure of categories and that this polarity motivates much of the work the theory does. The prime objective is to provide an account that links the 'effective' with the 'ineffective' categories, 'unobservables' with 'observables,' 'theory' with 'observation,' and so forth.[167] Cognitive criticism in mechanism is therefore often mediated by cognitive instruments whose 'validity' and 'efficacy' are thought to be independent of experience or perception – for the latter are seen with general scepticism and are accused of being delusional.[168] Mechanism thus typically works in consort with 'deductive logic' or mathematical proof (i.e., systems of axiomisation) to model the specificity of determination. 'Deductivism' is a preferred tool because it preserves truth by necessity; this means that the conclusions of deductive inference can be guaranteed if only the premises are valid. In mechanism, knowledge about the world is therefore typically secured by successfully deducing the exact constellation of observable facts from one's initial premises. The offered explanations are 'basic' in this sense – they target processes of determination concerning the 'primary categories' of reality. To establish truth in mechanism requires the specification of constitutive grounds for something to 'happen in the world' (cf. Salmon 1984; Woodward 2003).

It seems only consequential that mechanists favour strict hypotheses testing as a corroborative method; a hallmark of their mode of hypothetical reasoning is that the test conditions and empirical correlates are defined as granular and as exact as possible (the definition, in other words, reflects an attempt to develop 'precision' and typically includes the discrimination of relevant and irrelevant fea-

[164] This notion of 'prediction' was for example accepted by Hume and many, if not most, 'logical empiricists' (cf. Barrett and Stanford 2006: 587).
[165] A well-known example of a defence of this view is Carnap's *The Logical Structure of the World* (1967).
[166] Pepper (1942: 220) clearly sees that over-stretched 'repetition' of cosmic geometric threatens to bring down 'mechanism' and to turn it into 'formism.' Ever repeating configurations and correlations would simply call for an explanatory category of 'subsistence.' Radical repetition must therefore by avoided in 'mechanism' and this typically happens by acknowledging some sense of 'boundedness' separating varying 'fields of causality' (which, by the way, sometimes pushes 'mechanism' close the 'contextualism'). In the context of 'mechanistic' Gestalt theory, Pepper explicitly (*idem*) notes: "[…] [t]he formistic threat to mechanism of a catalogue of elementary mental atoms which are identically repeated in multitudes of complex mental states is obvious enough. What are these atoms but the very immanent forms which formism is built up from? […] The difficulty can be avoided only be conceiving of the great machine as a highly structured field that never literally repeats itself in any details and that here, there, and elsewhere exhibits emergent qualities which are also never repeated in detail."
[167] The distinction between 'observational' and 'theoretical' language in 'logical positivism' provides a telling example here (cf. Godfrey-Smith 2003: 28); the distinction can be interpreted as an extension of the categorical difference between 'primary' and 'secondary' qualities in 'mechanism.' 'Red' for instance belongs to the 'observational' part of language and describes a 'secondary' quality of the world, whereas 'electron' belongs to the 'theoretical part of language and describes a 'primary' quality of the world. In order to advance science, one ought to analyse this distinction and make use of it. This is another example that shows that the 'empiricist' tradition in philosophy could often not resist the 'mechanistic' attraction.
[168] Here lies the specificity of 'mechanism' and its mode of cognitive criticism; its theory of truth is inconsistent with unchained empiricism. Empirical facts, according to 'mechanists,' cannot be taken at face value and their cognitive status is always double-edged; this is why one cannot simply compare facts with knowledge claims and thereby establish scientific truth. Yet, 'mechanists' do not deny that empirical evidence is the only reliable road to knowledge. Cognitive criticism in 'mechanism' therefore mirrors the theory's conceptual duality and seeks to satisfy two epistemic needs at once: first, to acknowledge what can empirically be observed; and secondly, to recognise that observation needs to be calibrated by non-empirical means. The specification of causal structures and their empirical consequences is a non-empirical task, while the assessment of these consequences through observation is obviously empirical.

tures in the world). Many mechanists, moreover, gravitate towards *hypothetico-deductive strategies* of cognitive criticism (cf. Hempel 1966)[169] and try to feed them with invariant causal principles and potent considerations from general theory. Alternatively, mechanists attempt to pre-cast the systemic structure of whatever they wish to examine in causal terms (cf. Pepper 1942: 228) – a practice that often results in process- or flowcharts and lays bare the hypothesised links of determination between various parts, so that their causal enchainment can be closely investigated and tested.[170] Mechanistic theories of truth hence generally rely on a convincing operationalisation of two key assumptions: first, that test conditions and empirical consequences can be formulated in such a way that one can ensure their discriminatory power; and secondly, that hypotheses can generally be tested in isolation.[171] In order to achieve this, mechanism tends to introduce and develop specific and often quite elaborate 'theories of testability.'[172]

Mechanism's theory of truth typically paves the way for 'nominalism' (Pepper 1942: 226).[173] Many mechanists are nominalists insofar as they deny that there is room for transcendental entities in the world, or at least for entities that exist outside of space-time locations.[174] Mechanism's 'nominalistic turn' is hence an expression of its general scepticism about the types of universals that 'formism' advocates and defends – in particular 'subsistent' universals. For mechanists, the acceptance of such universals brings us far too close to the ideational world of Platonism, where an ever-changing reality of forms is juxtaposed with its 'eternal' counterpart. Mechanism's attraction for nominalism is therefore simply rooted in its determination to overcome the 'existence'-'reality' opposition that prevails in 'formism' and to reinterpret the form-matter relationship through its own categories (cf. *idem*); some mechanists are thereby prepared to accept that forms are nothing less than an actualisation of particular matrices of material forces – a trail of reasoning which greatly motivates 'materialism' or 'physicalism' (cf. e.g., Ney 2009).

Another important ramification of mechanism's conception of truth is that correlation can no longer be regarded as a potential truthmaker – it can at best hint towards scientific truth. In mechanism, correlation hence becomes no more than a means to grasp relationships between the 'effective'

---

[169] It should be noted that some aspects of Carl Hempel's (1965) 'covering-law' conception of explanation are consistent with 'formistic' modes of knowledge corroboration, in particular with the idea that participation in laws should be a reliable truth-indicator. From this perspective, Hempel's 'covering-law' conception can be interpreted as formalisation of 'formistic' principles by means of deductive logic.

[170] This tendency easily gives way to 'externalist' strategies of explanation (see *supra*). 'Causal-adjustment' then simply comprises of distinguishing between phenomena and their environment and to demonstrate that the former was an expected consequence of the causal connections between the phenomenon and its environment (cf. Pepper 1942: 228). As Pepper (*ibid*.: 230f.) emphasises, this strategy often leads to a relapse into the similarity criterion of 'formism' and illustrates how difficult it is for 'mechanism' to bridge the 'observable'-'unobservable' gap.

[171] This relates back to the 'specifity of response' principle. A constant threat for knowledge corroboration in 'mechanism' is illusionary or inconclusive testing. 'Mechanism,' in other words, needs to make sure that negative or positive test-results remain unequivocal. This is more difficult than it appears to be. For instance, a rejected hypothesis might simply tell that part of the premises of the original research question that motivated the hypothesis were flawed; an accepted hypothesis, similarly, might simply tell that the discriminatory power the hypothesis was not sufficient. This is known as the problem of 'holistic testing' (cf. Feigl 1943; Quine 1951a) it follows that 'mechanism' has to ensure that the responses it envisions and analyses are specific enough to circumvent this problem.

[172] Such specific 'theories of testability' are not necessary in 'formism' since this theory interprets 'testing' in terms of its root metaphor of 'similarity;' to test a knowledge claim there simply means to analyse its structural similarity between the proposed knowledge claim and the facts in the world it concerns.

[173] The theory of nominalism, in its original scholastic formulation, holds that general terms and abstract concepts are no more than 'word utterances' and can have no independent existence (cf. Feibleman 1962). As we have seen, this is also the reading of the 'empiricist' tradition in American philosophy and has motivated its distinction between 'observational' and 'theoretical' terms (see *supra*). Everything that is real, according to this theory, must be grounded in some concrete 'particular(s).' *Ockham's Razor* can be interpreted as a pragmatic manoeuvre to secure nominalism in truth-finding and is often introduced in the guise of 'parsimony' considerations (cf. Sober 2015: Chapter 5). Having said this, there are at least two varieties of nominalism to be distinguished and 'mechanists' have not always found it necessary to embrace both of them: nominalists may reject either 'abstract objects' or 'universals' (cf. Rodriguez-Pereyra 2016). The first version denies the existence of Platonic 'ideas' or what some researchers identify as 'non-spatiotemporal' or 'causally inert' objects; the second version denies universals insofar as they are defined as existing outside of space and time or as occupying more than one place in the 'field of locations.' The first variety is more important in the types of 'mechanism' that are relevant for Palaeolithic archaeology and is commonly embraced there to counter 'conceptualistic' and/or 'organicistic' interpretations of past realities. Although many 'mechanists' try to be 'scientific realists,' the 'consolidated' variant of the theory would collapse, or at least relapse into 'formism,' if all of its consequences were embraced.

[174] Since the 'field of locations' belongs to the 'primary' categories of 'mechanism' and since especially 'consolidated' variants of the theory tend to recast it as an integrated spatiotemporal field structure, 'mechanism' cannot except the existence of something beyond or outside of this structure. The attempt to integrate everything that exists into a single consolidated spatiotemporal field inevitably introduces reductionism(s).

and 'ineffective' categories, and to investigate their regular co-occurrence;[175] alternatively, it can be used to tackle the problem of 'equifinality' or to track down similar causes acting upon different aspects of reality. Correlation can thus never be an explanation itself, but instead always requires further explanation.[176] This is because contrary to 'formism' correlation in mechanism is opposed to causation, and the relation between the two is always problematic and rarely symmetric (cf. Pepper 1942: 230) – the types of explanatory regularities mechanism is looking for, in other words, may contain but do not exhaust themselves in 'laws of association' (*sensu* Cartwright 2004).

2.6.3 *Operationality as the truthmaker in contextualism*

The cognitive criterion for truth in contextualism is *workability*.[177] This conception undermines *bona fide* and/or overly 'substantive' definitions of truth and knowledge (cf. Annis 1978).[178] Since truth is interpreted through the contextualistic root metaphor, what scientific truth amounts to turns out to be *context-dependent* itself.[179] Many contextualistis, in fact, consider it likely that there is no such thing in the world as universal truth conditions. What Pepper (1942: 268) dubs the 'operational theory of truth' expresses this general conviction. The notion of 'operationality' gives thereby credit to the contextualistic belief that concepts such as 'truth,' 'veracity,' 'certainty,' and/or 'knowledge' are primarily the result of an *inquiry* and, consequently, cannot be defined independently of this inquiry. A key intuition here – consistent with the structural categories of 'novelty' and 'change' – is the 'mutability' of truth.[180] It is for this reason that contextualism sometimes gives a voice to 'deflationist' tendencies of cognitive criticism; another consequence is that contextualists typically place much more corroborative weight on 'assertability' or 'acceptability' as cognitive criteria than on 'certitude' or 'reliability.' The idea that knowledge can be certain is often rejected as self-contradictory.

Operational theories of truth author relatively modest standards of epistemic excellence and consider knowledge simply to be a product of successful, persuasive, and/or neoteric inquiry. A knowledge claim can be said to be 'admissible' if the inquiry that yielded it did overcome all interrogative obstacles. According to contextualism, the surmounting of interpretive problems clears the path for a consistent description of the context defined by the inquiry.[181] 'Assertable' knowledge is therefore knowledge that originates from the removal of all relevant knowledge barriers such as interpretive inconsistencies and/or blocked 'strands' or 'references' (Pepper 1942: 269; cf. **Box 8**). Since contextualists tend to focus on relations and relationalities in the accounts they provide, inquiry typically demands to find a way of organising the totality of the observed relations so that the resulting whole makes sense, that is, can come into view in its 'wholeness' (qua its 'quality' and 'texture'). The 'harmonisation' of context-internal relations is a cognitive strategy to secure this 'wholeness,' but the 'hierarchisation' and/or 'dichotomisation' of relations is at least equally important.[182] Because contextual-

[175] This effectively engenders a test for whether these co-occurrences can be predicted or not; if they can be predicted, 'mechanists' have some reasonable ground to belief that some causal principles are involved.
[176] This is obviously the source of much conceptual confusion and 'mechanism' must uphold the categorical distinction between 'correlation' and 'causation' to be consistent and to make adequate use of its proper root metaphor (see **Appendix II**).
[177] 'Workability' as a cognitive criterion is broadly understood here. Pepper (1942: 270-279) distinguishes three ways of interpreting 'successful working,' only one of which is defined by workability *sensu stricto*. We will return to this issue below.
[178] 'Contextualism,' in other words, remains sceptical about theories which attempt to secure the 'inertness' of truth and recast it as a feature of reality; this scepticism is only consequential since the 'contextualistic' theory is sceptical about 'inertness' and 'staticness' in general (cf. e.g., James 1914: 200; see *infra*).
[179] Explicating and analysing the truth-context itself, has thus historically been a major concern for many 'contextualists.' A well-known example is Charles Sanders Pierce's (1901) 'semiotic' theory of truth, according to which knowledge and human thought in general has to be understood within the context of sign relations. A 'sign' is thereby in classic 'contextualistic' terms: not as an 'absolute,' but as a relational and non-essential entity.
[180] The 'mutability' theorem has caused many troubles for 'contextualism' and its status and bearing are therefore controversially debated (cf. e.g., Putnam 1981: 55; Rorty 1998: 2). More recently, the 'mutability' theorem of truth has been modified into a general principle of 'conceptual relativity' that supports the idea of a multiplicity of concurrent 'conceptual schemes' (e.g., Davidson 1973).
[181] Consistency in contextualism is the *quality of being relatively uniform* – if we take writing an essay as an example, consistency is when the overall style and content of the essay turn out to be relatively uniform. Consistency must thereby be distinguished from 'coherence,' which is a category of truth fully developed only in 'organicism.'
[182] This is a locus of crucial difference between 'contextualism' and 'mechanism' for the latter seeks to determine a maximally limited set of causally highly effective features in order to explain, and typically insists on strict directionalities. 'Contextualism' counters this picture of the world by invoking multiple but in isolation only weakly determinative features, which effect all other features of the same context. One may therefore say that determination appears to be *contextually distributed* and can only be pointed at after the contribution of each part to the whole has been established. 'Contextualism' therefore possesses was William

ism seizes 'articulations' of facts and relations and because the latter, as a consequence, are usually regarded to be multi-directionally effective, meaning can also be extracted by eliminating interpretive difficulties through 'dialectic' logic. The context of explanation is therefore typically defined in extremely dynamic terms.[183]

Contextualism also subscribes to a 'processual' view of knowledge formation and corroboration.[184] The reason is of course that inquiry is defined contextually and often turns out to be a collective endeavour that is temporally ongoing – inquiry, in other words, has 'spread' itself.[185] The basic idea is that knowledge arises when knowledge claims manage to withstand prolonged inquiry and criticism. Contextualism thereby recognises that the removal of cognitive obstacles by one scholar in one research context is most likely insufficient to guarantee the strict 'assertability' of the resulting propositions. Individuals might have overlooked critical cognitive barriers and/or downplayed serious inconsistencies; other difficulties might have been truncated by the definition of the study context itself, and so forth. Moreover, some inquiries may not be completely successful in removing all sources of epistemic obstruction, but may nevertheless furnish readings that are 'more workable' than those previously offered. When contextualism talks about inquiry, it hence typically pluralises it and renders it a time-consuming communal enterprise.[186] Individual knowledge claims in contextualism therefore turn out to be generally 'incomplete' and 'provisional' – knowledge, as a consequence, tends to be conceptualised as a steady *approximation* of truth.[187]

Since contextualism's operational theory of truth preserves the former's 'synthetic' commitment, the assessment of the cognitive status of contextualistic knowledge claims is subjected to the principles of *holism*. This means that 'testing' or 'verification' must also be holistic.[188] Since nothing can be said with absolute certainty in contextualism, the discovery of interpretive problems during inquiry always threatens to tear down the entirety of the provided account, including its driving assumptions, classificatory decisions, terminology, and so forth. Cognitive criticism in contextualism is therefore forced to accept an 'all-or-nothing' logic; either all cognitive obstacles can be overcome or the inquiry must begin anew and potentially from scratch – this also implies that researchers have to constantly test out new interpretive angles and to tinker with new ways of framing their research in order to make sure that no difficulties have been omitted and that no alternative account can bring forth a description that works even better (cf. Pepper 1942: 269). Truth in this sense is only when global *intelligibility* and contextual understanding have been reached – that is, when all references have been 'satisfied' (*ibid*.: 268) The latter requires the specification of the place and role of each research item relative to its context and an exposition of how each of these items shapes other items and is shaped by other items.[189] This general conception of knowledge corroboration has been embraced by a number of classic writers, most of which have been working in the 'pragmatist' tradition. It finds its expression for

---

James (1914: 54f.) calls the general "attitude of looking away from first things, principles, 'categories,' supposed necessities; and of looking towards last things, fruits, consequences, facts."

[183] This interrogation yields the idea that truth itself must be amendable to the inherent dynamism of scientific questioning.

[184] This preoccupation expresses the anti-'Cartesian' attitude of 'contextualistic' conceptions of cognitive criticism – an attitude that is particularly hostile towards 'mechanistic' approaches to truth.

[185] For many 'pragmatists,' this has laid the ground for an explicitly 'genetic theory of truth' (cf. e.g., James 1914: 65f.). [the designation 'genetic' refers to 'genesis' here and means something along the lines of 'developmental history']

[186] We can say that truth-getting essentially becomes a 'purposive act' (*sensu* Pepper 1966) and 'knowledge' is therefore never merely 'obtained' but always *made*. 'Contextualism' acknowledges the active and inescapable role of the knower in processes of knowledge formation. 'Hermeneutic' theories of cognitive criticism take up this basic recognition – that the knowing subject cannot be eliminated from the context of knowing (e.g., Olesen 2013). *Hermeneutics* is hence nothing less than the systematic attempt to carry through the 'contextualistic' root metaphor and to analyse the 'situatedness' of all human knowledge as well as to make use of it, that is, to turn it into a cognitive virtue. The 'hermeneutic' concept of a historical *horizon* anchoring all human knowing is perhaps the most obvious reflection of this conception (cf. Hörisch 2010: 156f.). The core tenet of this approach to knowledge, accordingly, is the *rejection of subject-object ontologies*. For the French branch of recent 'hermeneutic' thought, see Ricoeur (1965, 2004); for the German branch, see Gadamer (1960), Habermas (1968, 1981), Apel (1979), and Oevermann (2001); for the Anglo-American branch, see Taylor (1971) and Geertz (1973). Foucault's (1969,1972) 'discourse theory' [*Diskurstheorie*] is also 'contextualistic' insofar as it examines how human knowledge production is necessarily embedded in and regulated by specific but historically plastic 'discursive formations.'

[187] 'Contextualism' does not generally differ here from 'formism' although the two of course disagree about the precise reasons and causes for this state of affairs. Generally speaking, the 'approximative' view of truth is anticipated by a world theory's 'dispersive' character and its resulting preoccupation with organising rather than integrating its evidence.

[188] This implies 'meaning holism' as it has for example been embraced by the 'later' Wittgenstein (1958) in his language philosophy (compare e.g., the notion of 'language games'). The meaning of individual words, according to this view, can only be determined by understanding their functionality in a wider sentence and language environment. This is a 'soft' ecology view of language and similar 'soft' ecology accounts are offered by 'contextualists' on almost all fronts of scientific research.

[189] It is this capacity of 'contextualism' to provide a dense and experience-near 'connectivist' account of our perceptual competences that is often seen as its main cognitive achievement (e.g., Henderson 1994: 647).

example in the well-known Pierceian slogan that 'truth is the end of inquiry' or in William James' (1914: 222) proclamation that "truth is satisfactory to believe."[190]

The interpretation of truth through the lens of contextualism's operational theory leads to three distinct strands of knowledge corroboration. Pepper (1942: 270-279) suggests that these original ways of going about the problem of contextualistic knowledge-capturing are (i) 'successful working' *sensu stricto*, (ii) 'hypothetical verification,' and (iii) 'qualitative confirmation.' The first strand directly captures the initial intuition of 'contextualism' and recasts corroboration as a question of immediate epistemic utility (*ibid*.: 271); this utility concerns the factual findings themselves and does not rely on explicit hypothesis formulation (*ibid*.: 272). Obviously, epistemic utility in this sense can only be assessed relationally and often requires retrospective judgement. The second strand is what Pepper refers to as 'direct verification' by means of hypotheses formation. It represents a complexification of the first strand but hypotheses formation remains dependent on interpretation (cf. *ibid*.: 273f.).[191] The third strand, finally, stresses the importance of a 'thickened' account of whatever one wishes to understand, so that verification consists in carrying through both the 'quality' and 'texture' of the target of interpretation (*ibid*.: 275-278).[192] This often translates into a call for interpretive richness and tends further to complicate the stream of inquiry.

Although contextualists are well aware of the fact that they produce 'situated' knowledge and that each interpretive context might be unique itself, they can nonetheless legitimately mobilise their *interpretive experience* – that is, the insights they have gained from earlier inquiries – to make informed speculative leaps to reach out to new contexts of inquiry (cf. Pepper 1942: 278). These leaps, however, may never usher the final word and rather have the status of pre-analytical hypotheses which help to narrow down the range of promising entry points of inquiry; their function is to define the beginning of a new inquiry, not the end of it.[193] Interpretive experience may also serve to intuit promising strategies for effectively organising the totality of evidence and to come up with suitable tactics to avoid the kinds of interpretive trouble previously encountered. This, together with the recognition that truth is always 'processual' and 'historical,' leads many contextualists to regard first-hand and object-specific experience as a necessary precondition for successful and reliable knowledge formation.[194]

2.6.4 *Coherence as the truthmaker in organicism*

The basic principle of knowledge corroboration in organicism is *systematic coherence* and most organicists are indeed coherence theorists of truth (Pepper 1942: 310; cf. Joachim 1907: 76).[195] Coherence as a cognitive criterion of scientific 'validity' gives voice to two interrelated pillars of organicistic thought: first, as a goal it signals that the world is accessible only in its fragmented, chaotic, and heterogeneous constitution ('disintegration'); secondly, as a method it signals that the proper nature of worldly phenomena can only be grasped if it is shown that this heterogeneity turns out to be productive and can be arranged into coherent sub-sets ('integration'). For organicists, this account of truth is only incon-

[190] In *Pragmatism: a new name for some old ways to think*, James (1914: 58) adds that "[…] ideas (which themselves are but parts of our experience) become true just in so far as they help us to get into satisfactory relation with other parts of our experience, to summarise them and get about among them by conceptual short-cuts instead of following the interminable succession of particular phenomena; any idea that will carry us prosperously from one part of our experience to any other part, linking things satisfactorily, working securely, simplifying, saving labor […]."

[191] This dependency is critical since it distinguishes verification in 'contextualism' from verificationism in 'formism' or 'mechanism' where the construction of an explicit and maximally transparent hypothesis is principally independent from the analysis of evidence (cf. Ayer 1936; Popper 1968). The formulation of testable hypotheses is sometimes regarded as a 'psychological' business there, strictly distinct from empirical examination. Verification in 'contextualism' seeks to overcome this mind-world duality. Hypothesis in 'contextualism' is imbricated into analysis and turns out to be a means to 'blaze' the cognitive trail.

[192] The resulting interpretive accounts tend to be detailed but *qualitative*. It follows that interpretive accounts speaking about different objects in the world are difficult to compare; comparison is therefore rather generalised and mainly confronts the 'quality' of the examined wholes.

[193] This issue of reaching out to new interpretive contexts and to effectively relate different contexts of inquiry provides the ground for one of the major internal difficulties of the theory (see **Appendix II.2** for a detailed exposition). Nonetheless, this is one of the ways in which 'contextualists' may mobilise prior knowledge to make sense of new contexts and to employ corroborative strategies of 'hypothetical verification.'

[194] Unfortunately, this often wages 'ad hominem' arguments and favours tacit appeals to authority.

[195] Classic coherentist accounts of knowledge such as BonJour's *The Coherence Theory of Empirical Knowledge* (1976) and *The Structure of Empirical Knowledge* (1985) stress their anti-foundational attitude as well as their intent to strengthen the authority of empirical facts (e.g., Elgin 2005). [It has to be noted, however, that BonJour subsequently turned to foundationalist viewpoints again.] A central motivation of this position is to circumvent problematic mind-world dichotomisations (cf. Whitehead 1929; Young 2016).

sistent as long as we conceive of reality as a static (and hence atemporal) entity. The key to the understanding of organicism's proper theory of truth is therefore its conception of time and temporality (*ibid*.: 311f.). The simplest and perhaps most effective way of making use of coherence as a criterion of cognitive criticism is to delineate phenomena as they travel through time and to analyse their itineries (e.g., Thompson 2007: Chapter 7).[196] Cognitive 'veracity' can be reached if this analysis yields a coherent account of the observed temporal behaviour(s) (e.g., Bergson 1907; Simondon 1958).[197] When organicists contend that something is 'coherent,' they hence typically mean to say that its temporal behaviour 'makes sense.'[198] Coherence in organicism is consistency plus: it places emphasis on *locality* and *order*.[199] If we want to say that something is 'true,' this something must occupy a difference-making place in extended spatiotemporal reality – it must be 'bounded' and 'effective' – and has to demonstrate organisational cohesion.[200] Knowledge, according to coherence theories, is thus typically to be defined as the *orderly consistency of a local set of truthbearers* (e.g., Bradley 1914; Young 1995, 2001; cf. Pepper 1942: 310).[201]

It cannot be stressed enough that the detection and delineation of 'effective' local sets, that is, sets of facts which turn out to be arrangeable in an orderly consistent manner, is already a large part of the work that an organicist has to do. Not all possible sets of fact can be ordered in such a manner and it is in this way that organicism remains responsive to the 'objectivity' of fact. To show that coherence among a sub-set of facts can be reached therefore amounts to nothing less than a demonstration that the sub-set has explanatory significance.[202] This is precisely how organicism typically carves out and defines its wholes – as 'effective' (but temporally extended) sub-sets of facts. The corroborative procedure that organicism imposes on its advocates is therefore always 'dialectical' in its core: it consists of a constant reconciliatory movement between the selected parts and their reconstructed wholes in order to ascertain the cognitive significance of them both (cf. Pepper 1942: 312).[203] In order to secure scientific truth, organicism sets forth to isolate a meaningful assembly of 'fragments of reality' and to verify its meaningfulness by resolving these fragments into temporally structured wholes without substantial loss – how the fragments can be resolved is thereby a question of their 'nexuses' (*idem*; cf. **Box 9**).

This corroborative strategy of organicism leads to the temporalisation of truth (Pepper 1942: 311, 313). By temporalising truth, organicism provides substantial grounds for the idea that the 'here and now' can only be an imperfect standard of truth since the present is itself only a fragment in time

[196] This conception is deeply sedimented in French intellectualism and is reflected in the writings of Canguilhem (1977), Badiou (1988) Derrida (1967, 1993), and Simondon (1964, 2014) – the problem of truth is in fact often described there as the historical tension between the 'objective' or 'concrete' and the 'ideal' in the world, which, in turn, has given credence to the notion of a 'history of truth' (*histoire de la vérité*) (cf. Balibar 2002).
[197] This can be seen as a radical re-interpretation of the 'contextualistic' finding that contexts have 'spread.' A key difference, however, is that 'organicism' introduces a weighty asymmetry – an asymmetry that 'contextualism' is not ready to accept. This asymmetry consists in the conception that time legislates over space and is therefore primary to the latter. The temporal 'spread' of a phenomenon, in other words, is typically larger and more decisive than its spatial 'spread' – the former therefore typically conditions the latter. We can say that 'organicism' is mainly concerned with the analysis of the consequences of this configuration.
[198] This marks a break with 'contextualism' insofar as the categories of 'novelty' and 'change' are re-interpreted sequentially (i.e. as 'stages'), but as 'connectors' rather than as 'separators.' While 'contextualism' aims to provide a rich account of a whole's spatiotemporal situatedness, 'organicism' tries to explain how different whole's follow up on each other so that their succession makes sense and reveals their integratedness (which is to say that in reality, we are dealing with merely a single but ever-transforming whole).
[199] Pepper (1942: 310) tries to capture this specific 'organicistic' preoccupation with coherence in the following way: "[i]n other views coherence may be treated as a gauge of truth but not as its essential nature. In fact, in other views than contextualism coherence is ordinarily confused with consistency, which is, as we know, but the formal shadow of coherence. For consistency is mere formal non-contradiction whereas coherence is the positive organic relatedness of material facts."
[200] 'Difference-making' simply refers to the capacity of the local set to enable an understanding of the part of reality it concerns, which otherwise would be inconceivable.
[201] It has to be admitted that there is a tendency, especially in 'analytic' philosophy, to distinguish between 'theories of truth' and 'theories of epistemic justification.' While the former specify what renders a statement true, the latter try to establish when an assertion is justified – the two issues often go apart. As a result, some scholars have adopted different views in the two domains, for example the previously mentioned BonJour (1985) who accepts 'coherentism' in the domain of justification but not when it comes to the theory of truth. The crucial point is that these cases must not concern us here because the very distinction between these domains is motivated by an 'analytic' conviction in Pepper's sense – 'organicists' would not accept such a compartementalisation of issues of corroboration and the 'organicistic' world theory, consequently, is grounded in a *global* variant of 'coherentism.'
[202] One can say in this way that the phenomenon is 'conceivable' and 'conceivability' can indeed be seen as a preliminary truth-indicator in 'organicism' (cf. Joachim 1906: 66) – a whole that is 'conceivable' is sometimes referred to as a 'significant whole' (*ibid*.: 68, 76).
[203] This is the 'thesis-antithesis-synthesis' structure of all 'organicistic' explanations.

(*ibid*.: 308; cf. e.g., Copleston 1994 [1974]: 188).[204] 'Truth' and 'knowledge,' in other words, can only be recovered if extended time scales are taken into account – in the extreme, organicists regard it hence as entirely pointless to talk about truth in an isolated given moment of time and view it instead as a property of the *longue durée*.[205] This involves the idea that 'conflict' and 'contradiction,' although they belong to the categorical architecture of organicism and are therefore presumed to reflect a structural characteristic of all reality, only persist in the moment or when time is 'mangled' and 'mutilated' (cf. esp. Bergson 1922); to ascertain coherency thus simply means to show that 'conflict' and 'contradiction' disappear when we shift our temporal perspective in proper ways.[206] This is the signification of 'integration' in organicism – the theory stresses the possibility and ultimate inevitability of integration but insists on the fact that such integration *takes time*.[207]

Organicistic knowledge corroboration consequently rests on the ability of scholars to elucidate how the 'progressive' categories of a phenomenon irreversibly remove the remaining structural counteractions and make progressively room for the 'ideal' categories to fulfil themselves.[208] Knowledge is only conclusive if the gap between 'progressive' and 'ideal' categories is closed, so that the two cannot be told apart anymore (cf. *ibid*.: 314).[209]

The general character of coherence-based knowledge results from the organicistic root metaphor of the living being as a unity that 'breathes,' 'struggles,' 'develops,' 'learns,' and 'adapts.'[210] This picture culminates in the view that truth and knowledge can never be evaluated based on a single condensed proposition or a limited number thereof,[211] for there is nothing in the world that could be said to render such a proposition 'true.'[212] Instead, the 'credibility' of an interpretive account must be gauged by apprehending it as an organic whole with many vital parts itself.[213] These parts are typically identified as propositions and sub-propositions, arguments, descriptions, and other instrumental features of the analysis (cf. Joachim 1906: 37); organicism seeks to show that these organically stick together and form a perfectly interdependent whole.[214] The truth conditions of assertive propositions are therefore mainly to be found in *other propositions* (cf. e.g., Williams 1980). It follows that a knowledge claim is definable as a coherent bundle of many such propositions[215] – coherence, in other words, comes into view as the character of a structured mesh of propositions exhibiting a sound organisation-

[204] This realisation has led many 'organicists' to propose that the 'present' is merely an illusion, created by the limitation of human temporal existence and perception; in reality, what we call the 'present' is always pregnant with the future and also encompasses the totality of its effective past. Henri Bergson's (1907) interpretation of time as *duration* provides a classic example here.

[205] Needless to say, this conception is terribly at odds with the 'uniformitarian' agenda of mechanism and the 'eternalist-universalist' preoccupation of 'formism.'

[206] From the perspective of 'contextualism' one may say that 'conflict' and 'contradiction' are thereby shown to be part of the 'texture' of a temporal phenomenon rather than being characteristic of its 'quality.' Of course, heterogeneity thereby not simply 'disappears' or 'vanishes' but is rather shown to be ordered in such a way that it enables the 'homogenisation' and 'crystallisation' of the whole.

[207] Typically, this is simply done by showing how the initial conflicting set of propositions is gradually *integrated* into a relatively coherent set.

[208] Strictly speaking, 'coherence' is itself an 'ideal' category and can thus never fully be realised, so that knowledge corroboration attempts to approximate it; this is another reason why it may be wiser to speak about 'consistency plus' here.

[209] It is very likely that that this condition can in principle never be reached because it would force the theory to resolve its own structural footing which, in turn, would lead to the theory's ultimate collapse (see **Appendix II.2** for a detailed exposition of this difficulty). The consequence is that 'organicism' can only author inconclusive knowledge and must accept that it works towards a goal which it can probably never reach. This, of course, is not necessarily a problem and may in fact explain why scientific inquiry will never become dispensable, but it implies that 'organicisitc' knowledge claims can only be judged in light of other competing 'organicisitc' knowledge claims – in terms of their relative capacity to close the gap between the 'progressive' and 'ideal' categories of a phenomenon.

[210] Cf. Bergson (1907) and Canguilhem (1969) as life-theoretical prototypes (cf. e.g., Exteberria 2018 for a useful overview of these and similar 'organicistic' tropes in philosophy).

[211] The term 'proposition' is not used in a technical sense here but simply refers to whatever might be a possible bearer of truth – what these are typically differs between 'organicists;' in fact – as we see below – to identification of relevant truthbearers is part of the work that the theory does.

[212] For the specific view of 'information' which is tied to this approach, see e.g., Barthélémy (2015: 32-37).

[213] The 'organcisitic' whole is therefore a 'living whole' which is highly dynamic and may continuously transform, but in a self-contained manner (cf. Joachim 1907: 80) – this is the contrast to be drawn to a 'contextualistic' whole which is also structured but not necessarily in temporally coherent fashion.

[214] Knowledge claims are hence interpreted as irreducibly complex living systems can only be judged in their systematicity and self-sustainability.

[215] This conception, almost by definition, predisposes 'organicism' to host *highly complex knowledge claims* which themselves are only intelligible in their propositional and argumentative structure. The resulting type of knowledge is often difficult to comprehend for the 'analytic' world theories since they are conditioned to simple and directly testable 'atomistic' statements.

al *logic*.[216] Harold Joachim (1906: 76) has given a now classic voice to this general conception: "[t]ruth in its essential nature is that systematic coherence which is the character of a significant whole." Many coherentists would indeed posit that any given belief is true *if and only if it is part of a coherent system of beliefs* (cf. Blanshard 1939; Cornelius 1972).[217] Organicistic 'beliefs' are thus typically interpretive verdicts about a fact – with Pepper (1942: 308), we can say that "[e]very fragment [of reality] is a *judgement* referring to a fact, the reference being represented by the nexus" (emphasis added).[218]

Just like in 'contextualism,' knowledge corroboration in organicism is generally 'internalistic.' The strategy, to recall, is to show that the internal heterogeneity of the individuated whole – a temporally extended phenomenon – is a heterogeneity among its parts that makes sense if the whole is examined in its 'development,' 'genesis,' 'growth,' evolutionary 'differentiation,' and/or 'integration' (Pepper 1942: 312f.). Since coherence stresses 'locality' – organicists seek to map localised wholes – it also rejects notions of strong 'catholicity' in knowledge corroboration.[219] Knowledge claims have to take stock of domain- and object-specificities – that is, they have to address how 'modes of being' interact with 'modes of becoming' (e.g., Souriau 2009 [1942]; Simondon 1958; cf. Latour 2011).[220] More often than not, organicistic explanations consist precisely in demonstrating how object-specific capacities, potentials, and behaviours lead to specific realisations of more general or even universal developmental trajectories. This reading of the evidence lends support to the idea that *time itself is object-specific*, so that object-specific temporalities can be invoked to understand how different objects behave in time (e.g., Deleuze 1966, 1968; cf. Smith 2013).[221] Inherent organisational complexities of the examined objects can then be viewed as factors that *enable* insight rather than block it. Moreover, the focus on the object-specificity of behaviours, tendencies, capacities, potentialities, and so forth requires organicists to embark on extensive and often intricate argumentative journeys. Quite regularly, therefore, qualitative argumentation and general considerations about structural constraints and possibilities ('nexuses') emerge as the key instruments to secure the 'organic' coherency of assertive statements.[222]

2.7 **Putting world hypotheses into perspective**

This chapter has shown that Pepper's map of cognitive tendencies provides a readily usable and extremely valuable tool to better understand general differences in how scholars harness evidence and

[216] This notion of 'logic' indeed often features central in 'organicistic' accounts; it gives a general voice to the intuition of organically inter-related parts that resonate with the whole. That these relations exhibit a certain 'logic' is another way of saying that they make sense in an 'orderly consistent' manner. The cognitive appeal to 'logic' is hence structural (it has nothing to do with formal or symbolic logic as it is used by the 'analytic' theories) and often synonymous to appealing to 'coherence' (cf. e.g., Balandier 1974).

[217] 'Organicistic' truth is therefore often localised as a property of what Quine and Ullian (1978) have famously termed the 'Web of Beliefs.'

[218] In the eyes of the 'analytic' world theories, such talk is seen as rather 'esoteric' since these theories typically deny the relevance (and sometimes even existence) of object-intrinsic *potentialities* as shapers of reality.

[219] It has to be said, however, that 'organicism' clearly accepts universal *rules* and somewhat generalisable *patterns of development* (the theory is anti-'nominalistic' in this sense). Yet, 'organicism' suggests that the respective 'rule sets' or 'patterns' are realised in *object-specific ways* and can typically only be shown to apply in *retrospect* – they can, in other words, be 'diagnosed' but not strictly predicted; prediction of developmental patterns is in fact only possible in a very general sense, without stipulating specific behaviours or if-then clauses. In contrast to 'mechanism,' 'organicism' is primarily concerned with the 'inertias' of its objects and focuses on how universal principles *drag* specific objects or phenomena, not how they propel them.

[220] The classic reading is that a single 'mode of becoming' tied to a given object-specific evolutionary lineage gives rise to a multiplicity of different 'modes of being.' In fact, 'organicism' would interpret a unique 'contextualistic' situationality as one such 'mode of being,' as a spatiotemporally specific manifestation of a more general 'mode of becoming.' However, the numerical and logical relationship between 'modes of becoming' and 'modes of being' cannot be determined *a priori* and 'organicists' would generally content that these a precisely the kinds of empirical questions we would have to ask in order to advance of knowledge about the world.

[221] This is another reason why truth in 'organicism' cannot be pinned down in time and why the 'mechanistic' conception of a 'field of locations' existing independently of particulars (i.e. material objects) makes no sense in 'organicistic' world theories; 'organicism' instead supports time-'subjectivism' insofar as we can say that each object-specific developmental trajectory inaugurates its own specific 'field of locations.' 'Organicism' is the world theory that is most radical in openly advocating extreme spatiotemporal relativity (something which is ironic given that Einstein's theory of relativity is typically interpreted in 'mechanistic' terms).

[222] The attentive reader will realise that qualitative 'argumentation' rather than argumentative 'data matching' emerges as the *modus demonstrandum* here. We will come back to this issue in Chapter 3, but it can already be said that the difference is extremely important for characterising the tension between 'analytic' and 'synthetic' world hypotheses. A key aspect is that 'arguments' serve a different purpose in 'synthetic' theories because they need to ensure 'consistency' or 'coherence,' which often requires a cognitive appeal to general principles of human *rationality* (this is exactly why these theories often appear to be overly 'rationalistic' to the 'analytic' world theories).

make sense of the world. Pepper convincingly elucidates that Western intellectual history has hitherto produced four larger families of thought which delineate relatively adequate world theories – 'formism,' 'mechanism,' 'contextualism,' and 'organicism.' Each of these world theories is cognitively potent in its own right, but relies on a unique conceptual architecture and a specific theory of cognitive criticism. This means that these theories not only differ in how they generate and interpret evidence but also in how they make sure that their knowledge claims are resilient. The illumination of the intimate interdependence of a world theory's structural categories and its theory of truth is a major revenue of Pepper's metatheoretical perspective on the human systematic cognition.

The strict autonomy of world hypotheses which arises from this configuration makes it clear that the four relatively adequate world theories vary on almost all levels of inquiry and are not reducible to one another. Moreover, each of the theories is only adequate to the effect that no other world theory has shown greater cognitive adequacy yet. The latter implies that all four world theories are defective to a certain extent and face serious internal inconsistencies. 'Formism,' 'mechanism,' 'contextualism,' and 'organicism' are therefore equally successful *and* equally fallible in rendering the world intelligible. It follows that one cannot retreat from the *plurality* of modes of thought to be taken seriously, and there is no ground for discarding any of them.

The scientific enterprise is of course no exception and remains conditioned by the same structural characteristics; science is simply a highly systematised, critical, and refined mode of mobilising world theories – a view that *en passant* helps to counteract the 'sacralisation' of science as an almost supra-human endeavour. From this perspective, the actual diversity of scientific approaches appears to be a symptom of employing different world theories and combining them in various ways. Moreover, the mere notion of 'science' becomes hollow if not defined in relation to a world theory. Concepts of scientificity consequently rise and fall with the relative cognitive adequacy of their world theories. This not only defuses the 'demarcation problem,' but also establishes a more nuanced understanding of cognitive diversity in scientific research; it allows us to appreciate relativity without falling prey to unconstrained relativism.

As the chapter has shown in some detail, although there may be a vast number of irreducible world theories not all of them are necessary trustworthy. Cognitive adequacy is a non-arbitrary feature only of the most promising theories, those which have shown great reliability and the capacity to refine themselves by withstanding cognitive scrutiny throughout Western intellectual history – 'formism,' 'mechanism,' 'contextualism,' and 'organicism.' This non-accidental diversity of different modes of 'world-making' brings into view the 'disunity of science' and puts the notion of *scientific pluralism* on a new metatheoretical footing. Major divergences in scientific theory and practice should consequently become re-interpretable in light of Pepper's world hypotheses theory – such epistemological divisions should be reconstructable by referring to Pepper's conceptual vocabulary.

An important consequence of this view on the nature of science is that 'disciplines,' 'fields,' and other kinds of research consortia are not necessarily homogenous entities. The relationship between Pepper's world theories and the social and epistemological contexts of scientific practice – e.g., what has variously been termed as 'research programmes' (*sensu* Lakatos 1970) or 'research traditions' (*sensu* Laudan 1977) – is far from straightforward.[223] Quite often, in fact, the boundaries between different modes of 'world-making' and the borders of scientific disciplines stand *oblique* to each other. Disciplinary frameworks tend to host a multitude of world hypotheses and this, in turn, can be considered an important motor of lively debate and mutual criticism (cf. e.g., Gillespie 1982; Hayes et al. 1988; Daley 2000; Karimi-Aghdam 2016). Yet, scientific disciplines also tend to seize and occasionally even 'monopolise' particular modes of 'world-making' – this is what is sometimes tagged as the 'received view' in a discipline. These trends typically propel critical sociological and historical dynamics that strongly influence the overall character of different scientific endeavours. Disciplinary and intra-disciplinary diversification can thus probably be much better understood as an expression of world theory negotiation (see e.g., Harrell 1982) – in other words, distinct socio-cognitive sub-units of research – i.e., what

[223] Although I cannot discuss this problem in much detail here, there are some more obvious possibilities to link the two. In the case of Lakatosian 'research programmes,' for example, it is possible to make use of the distinction between a research programme's *hard core* – that is, its basic and most essential ideas – and its *protective belt* – that is, its less fundamental and more 'operative' ideas typically used to apply the 'core' to actual phenomena. In the case of 'research programmes,' we would hence need to isolate the 'hard core' if we wish to lay bare basic aspects of 'world-making' as described by Pepper's world hypotheses.

Ludwik Fleck (1979 [1935]) termed *Denkgemeinschaften* – might ultimately be powered by vastly distinct world hypotheses and different eclectic tendencies.

From this vantage point, it is also much easier to retrace why and how different disciplines can *relate* to one another in constructive and beneficial ways; mapping the dynamics of how world theories inform scientific approaches in the various contexts of science may thus help to elucidate how the 'interdisciplinary landscape' of science is organised and has developed through time.[224] The intimate interplay between axes of epistemic and normative orientation established by the four relatively adequate world theories plays an important role in this. The general epistemic and normative anchoring provided by world theories pre-structures the research landscape and predefines potential partners, 'cognate' fields or disciplines, and/or antagonistic formations of research. For instance, co-evolution and ideational exchange between different disciplines or research traditions is much more likely to occur within a broadly *shared* framework of 'world-making.' Needless to say, the charted structural affinities and trade-offs between the four relatively adequate world hypotheses constitute crucial loci of epistemic convergence and divergence in this regard. It follows that disciplinary interactions and transdisciplinary theoretical developments are likely to be explorable with the toolkit mustered by Pepper's world hypotheses theory; this could potentially result in new 'topological maps' of various research endeavours. It should even be possible to investigate, at least tentatively, whether and how various disciplines have contributed to the cognitive advancement of the four main root metaphors: 'similarity,' 'cause-and-effect,' 'situationality,' and 'being alive.'

All of these insights can be drawn upon to better understand what is at stake when disparate approaches invariably clash in scientific practice. The following chapters try to do precisely this. They represent an attempt to re-organise the diversity of approaches to the lithic evidence that are encountered when French and Anglophone research in Palaeolithic archaeology is taken into account. I will use the concepts and categories developed in the present chapter to throw new light on the nature of plurality exposed by the French-Anglophone divide. Although I will surely make mistakes, the reader is trusted to recognise the larger merits of my undertaking. We will begin with an exposition of the general structure of the French-Anglophone divide in lithic analysis before turning to the bearing of specific world hypotheses.

[224] The term 'interdisciplinary landscape' refers both to mutualistic interdisciplinary cooperation and to unilateral conceptual import dynamics. The 'interdisciplinary landscape' of science thereby defines how likely it is that different disciplines, fields, or sub-fields productive engage with one another and borrow or share their cognitive resources. Concepts such as 'cognate' fields/disciplines become comprehensible only if this 'interdisciplinary landscape' of science is understood. Co-evolutionary interaction between different fields or disciplines can be seen as a product of a particular structural configuration of this 'interdisciplinary landscape.'

Chapter 3

Mapping the French-Anglophone divide onto the analytic-synthetic polarity of world theories

"*When a conception permeates a thought collective strongly enough, so that it penetrates as far as everyday life and idiom and has become a viewpoint in the literal sense of the word, any contradiction appears unthinkable and unimaginable* [...] *The same difficulty arises even today if such concepts as existence, reality, and truth are used in an absolute sense.*"

– Ludwik Fleck (1979 [1935]: 28)

"*Cognition therefore means, primarily, to ascertain those results which must follow, given certain preconditions. The preconditions correspond to active linkages and constitute that portion of cognition belonging to the collective. The constrained results correspond to passive linkages and constitute that which is experienced as objective reality. The act of* ascertaining *is the contribution of the individual.*"

(*ibid.*: 40)

Abstract

Taking up the core insights of the preceding chapter, a new hypothesis is put forth about the nature of the French-Anglophone divide in lithic research and some of its cardinal characteristics are charted. It is argued that the division, on a macroscale, represents primarily a conflict between 'analytic' and 'synthetic' world theories. The attendant polarities in theory and practice are illuminated by drawing on Pepper's architecture of Western thought. The categories 'analytic' and 'synthetic' help clarify the logic of artefact recording; imperatives of research design and inference-making; the relationship between theory and data; and strategies of visualisation which underpin the dominant lithic approaches on both sides. In the final part of the chapter, two key themes in lithic inquiry – variability and complexity – are examined through a Pepperian lens in order to map some of the more tangible effects of the divide. The analysis elucidates that French and Anglophone approaches are based on oppositional premises, which are difficult to consolidate, integrate, or even compare. French technological research is 'whole-centric,' whereas Anglophone lithic inquiry is 'part-driven.'

3.1 **Pepper applied: a new hypothesis**

What can we learn from Pepper's construal of Western thought about the nature of the French-Anglophone divide? Most importantly, it allows us to recognise that irreconcilable lithic knowledge claims may have their origin in incompatible yet equally pregnant world hypotheses. The circumstance that French and Anglophone researchers regularly produce divergent interpretations of the lithic evidence can then be taken as an indication that their polarised readings are powered by different world theories or combinations thereof. This, in turn, suggests that the kinds of underdetermination we encounter at the French-Anglophone interface practically prohibit the independent selection of a particular world theory perspective. Clearly, this proposition deserves assessment.

We have also learned that the general structure of credible Western cognition generally predisposes scholars to either adopt an 'analytic' or 'synthetic' logic of world-making. Because French and Anglophone lithic research seem to uphold disparate discursive spaces and because there is a general interest of cultivating interpretive tension while still nurturing cognitive complementarity, the 'analytic'-'synthetic' polarity is thus expected to be a stronger organisational factor than, say, the 'dispersive'-'integrative' opposition among world theories. The resulting cognitive dynamics, mainly regulated by the 'analytic'-'synthetic' divide, would pre-structure the cognitive space that the two research traditions can fill. For these reasons, it has merit to approach the French-Anglophone divide in lithic inquiry as a clash of 'analytic' and 'synthetic' modes of cognition. Pepper's reconstruction of Western cognition, in other words, provides us with plausible arguments to surmise that the bifurcation of the lithic research landscape into French and Anglophone approaches is closely related to mutually exclusive world theory underpinnings. It furnishes a well-defined hypothesis that can be tested against the realities of lithic practice.

The hypothesis that the French-Anglophone divide represents a particular instance of the 'analytic'-'synthetic' thought-polarity comprises two additional expectations. We should not only be able to break down the variability of practice *between* the two research spheres, but also shed new light on the nature of their *internal* variability. If the 'analytic'-'synthetic' polarity accounts for some general features of the divide, some of the pertinent internal dynamics of French and Anglophone lithic research should be explainable in terms of the trade-offs between the two attributed pairs of world theories: French lithic approaches should rely on 'contextualistic' and 'organicistic' ways of marshalling the evidence; Anglophone inquiry, by contrast, should be characterised by 'formistic' and 'mechanistic' regimes of handling the evidence. This hypothesis, however, does not suggest that French and Anglophone approaches are necessarily successful in pursuing their cognitive ideal, nor does it imply that all practitioners will always be guided by 'pure' world hypotheses incarnations – we are, after all, dealing with *cognitive orientations* here. The hypothesised structural organisation of the French-Anglophone divide is outlined in **Figure 2**.

Importantly, this novel perspective on the French-Anglophone divide offers not merely a re-description of well-known differences, but clears the view for their *cognitive significance*. If the divide is the result of different world hypotheses at work, this would elucidate both its status and its stakes, enabling a more productive discussion of how it can successfully be navigated or bridged. Moreover, if the divide turns out to be powered by world theory dynamics, this would highlight the central role of research communities – or 'collectives of thought' – in lithic knowledge production, for only these are capable of developing and refining world hypotheses (see Chapters 2 and 6). Therefore, hypothesising that the French-Anglophone divide is generated by divergent world theory regimes involves an argument about the socio-historical nature of the divergence. The divide would then signify a true chasm of research communities occupying barely overlapping discursive spaces and cultivating their own cognitive tenacities (see Chapter 1). The divide, if reconstructed along these lines, would also come into view as a product of dissimilar historical efforts of rendering the available evidence intelligible. Through this prism, the clearly distinct historical trajectories of the two research spheres can be re-interpreted as an attempt to refine different sets of root metaphors (see Chapter 2), again suggesting that the epistemological grounds for lithic research have drifted apart.

The remainder of this chapter explores the first part of this hypothesis; it asks whether the general structure of the French-Anglophone divide can fruitfully be illuminated by drawing on Pepper's distinction between 'analytic' and 'synthetic' modes of world-making. I will refer to a number of case studies and discuss some key topics to examine this question. The analysis will remain rather general since the demonstration that the difficult relationship between French and Anglophone approaches in lithic research is created by a conflict between different species of world theories can only be the first step. The chapter is consequently a prelude of what follows. It seeks to chart the general organisation of the divide in order to legitimise a finer-grained analysis of its constitutive elements or building blocks. In other words, we first have to understand the basic logic of the divide before we can grasp the dynamics that guide particular cases of research within the two spheres. If the hypothesis is supported by the available evidence, this would not only shed new light on the nature of the relationship between French and Anglophone research traditions, but also substantiate the reality and epistemological weight of the division.

3.2 **The general structure of the division**

Can the general structure of the French-Anglophone divide be clarified by reference to the cognitive dichotomy between 'analytic' and 'synthetic' modes of reasoning? And if so, how exactly is the dichotomy implicated in lithic practice on both sides? In what way, precisely, does it structure the divide and sustains epistemological friction? In order to answer these kinds of questions, we need to recall that 'analytic' and 'synthetic' research are difficult to reconcile because they conceptualise the role and status of 'parts' and 'wholes' in an oppositional manner; they, in other words, reject each other's basic standards of knowledge formation and criticism. From an 'analytic' perspective, parts are seen as the primary building blocks of reality and wholes as composed or derived entities, inferable from part-configurations. From the vantage point of 'synthetic' inquiry, wholes instead legislate over their parts and are thus considered a necessary precondition for the respective parts to occur in reality – wholes are 'more than the sum of their parts' in some relevant sense. As a consequence, 'analytic' approaches typically rely on corroborative strategies in which parts are mapped onto hypothesised wholes in order to evaluate whether the two 'match' or 'follow' from each other; 'synthetic' approaches, by contrast, tend to promote corroborative criteria that emphasise the whole-qualities of the advanced knowledge claims.[225] In the context of the French-Anglophone divide, we therefore need to examine what the respective parts and wholes in lithic research are and what their function in the research process is. This task is not as easy as one may assume and requires a careful investigation of some basic features of French and Anglophone lithic inquiry.

I will start with a basic examination of how lithic assemblages are usually recorded and studied. What is the role of individual artefacts? And which type of information is gathered in order to reconstruct the assemblage-totality? I will then move to more general aspects of lithic research; the analysis will concentrate on the general quality of applied research designs and the adopted patterns of inference. What is the rationale that guides the architecture of lithic research? What is the general strategy of inference? This investigation leads me to the problematic relationship between theory and data. What can generally count as data in French and Anglophone lithic research? What is the status of theory and how does it relate to data-analysis? Is the distinction even significant? In a third step, we will explore whether, and if so, how 'analytic' and 'synthetic' research orientations are reflected in French and Anglophone visualisation practices. What is the nature and role of lithic imagery? Do French and Anglophone scholars adopt similar visual strategies or do they instead rely on distinct 'image-worlds' in order to interpret their evidence? In the last step, I will discuss two concrete case studies in order to illustrate how the 'analytic'-'synthetic' divide affects the basic character of the lithic discourse and empirical research. It is explored whether, and if so, how the divide is implicated in the treatment of lithic variability and the interpretation of technological complexity. In total, the exposition should provide a general introduction to the epistemological relevance of the 'analytic'-'synthetic' polarity in lithic knowledge production. It will set the scene for a more detailed investigation of lithic practice in both research spheres reported in Chapters 4 and 5.

3.2.1 ***Atomism and holism in lithic recording***

In the practice of lithic analysis, the difficult relationship between 'analytic' and 'synthetic' cognition can be expected to result in at least four sites of interpretive friction. These concern (i) the kinds and types of data which are to be retrieved from the source material; (ii) the localisation of the relevant bearers of information; (iii) the relevant unit(s) of analysis; and (iv) the preferred direction of inference. The example of recording lithic assemblages – a necessary precondition of analysing and interpreting the respective artefacts – illustrates some notable effects of policing these conceptual coordinates in a divergent manner. It is important to note that the differential handling of these four sites affects lithic inquiry already at the stage of processing the source material, before any proper method-guided data-analysis can be conducted. The resulting differences in the logic of research are bound to often poorly theorised, because taken-for granted, yet crucial practices of extracting information from the lithic assemblages under study. These practices respond to the question of how one can transform

[225] See Chapter 2 for a detailed discussion.

the artefactual evidence into a data-format that can be reliably digested in order to assess the general character of a given assemblage, ideally answering particular research questions. The key aspects of this process are so basic and so deeply ingrained that they are rarely explained in detail in the literature. The reason is of course that data construction is typically thought to respond directly to the chosen methodologies. In reality, however, preparing the lithic data and selecting the appropriate method(s) to investigate them are often not clearly separable. Both co-implicate each other and to ask which of them is primary is to ask the old chicken-or-egg question.[226] The basic kinds of information that are gathered from the lithic material constrain and respond to methodological needs at the same time. It is for this reason that an investigation of basic recording practices in lithic research is clearly warranted, promising some interesting insights into the nature of lithic inquiry on both sides of the divide.

What is the basic strategy of recording an assemblage in French and Anglophone lithic research? The straightforward answer is that Anglophone scholars tend to adopt a 'piece-by-piece' mode of recording, whereas French technologists typically favour an 'assemblage-based' strategy. But what does this mean exactly? It means that in Anglophone lithic research the relevant information is located in lithic 'parts,' which are defined as objects – individual lithic artefacts themselves – or parts of objects. The result is that the analysis is generally 'object-centred,' either transferring objects directly into discrete variables or documenting their parts as 'traits,' 'attributes,' and 'features' (e.g., Dibble 1995a: 103; Sackett 1999: 115; Armagan 2003: Appendix A, B [271-284]; Shea 2013: Appendix 2 [335-345]).[227] When Anglophone researchers speak about recording the whole of an assemblage, they normally mean to record every single piece individually (cf. Clarke 1968: 187; Binford and Binford 1966).[228] Of course, a size-threshold is sometimes introduced for practical reasons, but the present micro-*débitage* is typically not ignored. The important point is that the informational value of a lithic artefact is conceptually *independent* from the quality of the assemblage-totality:

> "The data of the discipline is the information observed about the attributes of these artefacts. [...] The total information from these sensory spheres of activity feed observations about all these attributes into the third sphere of synthesis and fit the best model or hypothesis to the observations for further testing. [...] Briefly, it is imperative to realise that 'perceived facts' or attributes are necessarily facts or attributes selected from a vast range possessed by every simple artefact. We may choose to perceive length, breadth, thickness and weight of a handaxe but we may not choose to perceive or to be aware of its chemical composition, its temperature, radioactivity, elasticity, refractive index and so on." (Clarke 1968: 14f.)

The reason is that the quality of the assemblage-totality is believed to be the result of the (accumulated) character of its parts. The assemblage is primarily recognised as a *compositional* entity – as a 'derived' feature of reality. This conception is directly reflected in the dominant practices of assemblage screening. The 'object-centred' approach does not rely on visual or physical inter-artefact confrontations. The typical procedure is to unpack a single artefact, inspect and document its features, perhaps assign it to a general class of objects, and then pack it away again.[229] This approach emphasises analytical redundancy – all objects are checked for the same traits and attributes – and the comparability of individual artefacts and recorded characteristics:[230]

> "Study of the artefact collection initially involved going through each artefact in turn, checking and recording its provenance, and recording the range of data identified at the outset as relevant for analysis." (Wenban-Smith 2017b: 325).

[226] An important reason for the co-implication of data construction and the choice of research methodology is historical. Within a given research community, the two dimensions of inquiry are expected to develop in tandem and to adapt to each other in the course of disciplinary history. Because practices of data construction are 'inherited' to the same degree as, say, preferences for particular types of research methods, it becomes practically impossible to determine which of the two dictates the other. A more plausible scenario is that different research traditions *coordinate* their possibilities of data construction and their pool of preferred types of methodologies, so that the two can effectively support each other.
[227] This procedure is typically implied by the various trait- and type-lists provided in method sections or in extended appendices: they detail the kinds of artefact-level characteristics that are recorded and outline how they have been recorded (cf. e.g., Henry 1995: Appendices 8.1-8.17 [196-214]; Monigal 2002: 143-199; Scott 2011: Appendix; Tostevin 2012: 120-137 [esp. 120]; Byrd 2013: Wenban-Smith 2017a, 2017b; McPherron et al. 2018: 118-121).
[228] Historically important studies that have paved the way for an 'object-centred' approach to the lithic evidence in the Anglophone world are Spaulding (1953) and Sackett (1966).
[229] One may say that the confrontation of features and objects is already part of data-analysis. It is therefore not required at the data construction stage of lithic inquiry.
[230] Consequently, the recording process itself does not depend on the size or completeness of the studied assemblages.

In French technological research, by contrast, the relationship between 'parts' and 'wholes' is extremely dynamic. An isolated recording of individual lithic artefacts and their characteristics, without having established the assemblage-context first, is highly uncommon, some would certainly say unthinkable. The reason is that the signification of parts cannot be established without having grasped some whole-qualities. This is perhaps most clearly reflected in the widely-adopted habit of spreading the entirety of the studied assemblage on table boards for visual cross-reference and direct physical confrontation (e.g., Tixier 1978, 1988; Villa et al. 2005: Fig 5; Soriano et al. 2007, 2015).[231] In practice, this horizontal exposition of the artefact-totality is also used to pre-arrange and pre-sort the assemblage into potentially meaningful sub-groups (e.g., technical, functional, typological, mineralogical). This logic of research incentivises scholars to find effective groupings of artefacts before they actually decide which lithic features and characteristics they wish to document in detail, if any. The point is that each lithic artefact has an informational value only in terms of its relatedness to other artefacts. This condition already anticipates that the same artefact characteristics can have a fundamentally different bearing in different assemblage-contexts (cf. esp. Perlès 1992: 243, Note 22).[232] Whether and how they should be recorded is therefore ultimately decided by the 'whole,' and may thus differ from assemblage to assemblage.

It must be emphasised that this process of assemblage exposition, artefact sorting, and constant re-grouping appears to be a *necessary* precondition of lithic analysis in the French tradition.[233] It not only indicates that the determination of significant wholes and sub-wholes is an essential building block of French technological inquiry, but also makes clear that 'parts' cannot stand for themselves.[234] Primarily recorded are technical *relationships* and artefact-group *interactions* rather than discrete attributes, measures, or traits.[235] The informational value of an assemblage is therefore regarded to reside in the 'whole' of the assemblage rather than in its 'parts.' The assemblage, *qua* technological entity, is viewed to be 'more than the sum of its parts.' Lithic recording is not only a pre-analytical practice, it also furnishes some critical pre-understandings of assemblage-level qualities.[236]

An important consequence of this difference is that in French scholarship describing an assemblage does not necessarily imply to describe all of the associated artefacts. A complete description rather entails the adequate characterisation of the assemblage's 'wholeness,' specifying the place of as many individual artefacts as possible.[237] French technological research thus typically adopts an 'assemblage-centred' approach to the lithic evidence. Its mode of inquiry is *holistic*, lithic recording being

---

[231] Note that this information is often deeply hidden somewhere in method sections, footnotes, or figure captions; it is often not even explicitly mentioned because it has become such a commonplace practice among French lithic experts. It is thus perhaps especially telling that Paola Villa, originally trained in the United States, began emphasising this dimension of *chaîne opératoire* analysis when she started working intensively with French technologists: "[…] An efficient technological analysis requires that all pieces be taken out of their separate packets, marked with square and level and/or catalogue number and spread out to speed up the process of grouping in discrete categories while also checking for consistency in classification" (Villa et al. 2005: captions Fig. 5).

[232] See the first part of Chapter 5 for a detailed discussion.

[233] It is for this reason that the practice of 'living and sitting with' both a visually and physically exposed lithic assemblage for days or even months is such a crucial process in French technological research.

[234] See especially Valentin (1995: Annexes [1-19]), where the author develops a specific vocabulary to tackle the problem of describing and interpreting whole-level characteristics; the latter are not directly observable, if you will, in individual artefacts. In the case of Valentin, these characteristics have to do with the *volumetric management* of core matrices (see esp. *idem*: Fig. 6). The various modes of 'volumetric management' always implicate multiple different artefacts and there is no direct artefact-level correlate for them.

[235] The circumstance that the confrontation with other artefacts is a primary operation in French lithic recording leads to the somewhat paradoxical situation that artefacts themselves, although they clearly constitute assemblage-parts, need to be observed in their 'wholeness,' only then can they be meaningfully juxtaposed with other artefacts. The reduction of artefacts to mere numbers and attributes is generally inconsistent with this requirement. Tixier (2012 [1978]: 122), for example, notes that "[…] perception – whereby sight plays the dominant role – and near simultaneous overall identification lead to a comprehensive, a sometimes syncretic, understanding. The overall identification is altogether faster if the observer has a long practice or experience of the dialogue which takes place between a prehistorian and flint, which consists of the semi-unconscious registering of a multitude of visual images and tactual sensations" (original italics changed to underlining). The key point is that the 'tactual' and 'visual' *Gestalt* of a lithic piece is indispensable information itself.

[236] Needless to say, Anglophone researchers sometimes also spread their material on a table board. The point, however, is not whether they do it or not, but whether this practice makes a *difference* in how they record and interpret the evidence. An example is raw material units whose determination often requires the 'horizontal examination' of the artefact-totality. Yet, this examination typically effects only a single attribute, namely an individual artefact's raw material association. The rest of the recorded traits and attributes remains independent of this examination. One can add that there is a recent trend to assign raw material categories on the basis of clusters of raw material traits – a symptomatic 'analytic' manoeuvre which does not require any inter-artefact confrontation.

[237] What this wholeness exactly means must remain open for now. The issue will be taken up again in Chapter 5 and analysed in detail.

no exception. This also holds true for the somewhat special case of technological tool analysis – now commonly referred to as 'UTF-analysis' (cf. Boëda 1997, 2001). Although UTF-analysis is not always based on an 'assemblage-centred' approach and primarily examines individual tool-infrastructures, it is clearly 'synthetic' in orientation. As a special case of *chaîne opératoire* inquiry, UTF-analysis operationalises individual lithic tools (e.g., bifaces or Quina scrapers) as 'micro-wholes' and examines their parts accordingly.[238] The latter are typically understood as functional units ensuring the performance of the tool-totality. Having said this, such tool-wholes are usually placed into even larger wholes, so that they effectively constitute 'sub-wholes' which can further be related to other wholes within the wider assemblage-context (e.g., production systems) (cf. Lepot 1992/1993: Planche 87; Soriano 2000; Bourguignon 1997; Boëda et al. 2013). The inclination therefore remains deeply holistic. Moreover, this configuration has some notable implications for how object-samples are drawn. Typically, the strategy is not to draw a randomised sample; instead, scholars tend to pre-establish meaningful 'sub-wholes' and draw the sample in accordance to them (e.g., Soriano 2000). Thus, even sampling, strictly speaking, presupposes a 'synthetic' take on lithic assemblages and is an interpretive operation. The example of UTF-analysis also highlights again that part-whole relationships are negotiated in a highly dynamic manner.

The mode of recording that prevails in the Anglophone research sphere, as we have seen, is overwhelmingly *atomistic*. The guiding idea is that the lithic world is made up by a number of small but well-defined parts whose configuration provides primary insight into this world. It is through a more reliable understanding of these parts that scholars hope to pave the way for robust lithic knowledge. The French approach is counterposed to this conception. French technologists tend to assume that an adequate grasp of lithic wholes will lead to a more reliable understanding of their parts, and not the other way around. We will see in the next section that this difference has an important bearing on inference-making and the nature of the adopted research designs. All of this clearly confirms that the basic treatment of lithic assemblages is guided by fundamentally different research imperatives.

This general disparity between French and Anglophone approaches leads to starkly opposed conceptualisations of the data-world interface (**Tab. 3**). I will continue to explore these vectors of conceptual incompatibility throughout the remainder of this study. The two basic modes of handling lithic data, however, are a direct consequence of the 'analytic'-'synthetic' divide and deserve some clarification here. Because Anglophone modes of handling the evidence seem to be atomistic, the standards for describing and reporting individual lithic artefacts are held as constant as possible. The criteria of recording, in other words, turn out to be largely pre-defined, and the documentation of a lithic piece is a question of adequately applying these criteria. We can therefore say that Anglophone lithic inquiry, for the most part, appears to be rooted in a *democratic conception* of evidence, supporting relatively flat data-landscapes and rather generic categories of analysis. A potential consequence of this configuration is that the reportable number of independent artefact features is naturally limited, and possibly rather small. 'Analytic' lithic research thus tends to continuously play with more or less the same attributes and traits, and discusses the status of dependent and independent data.

This 'equality premise' clashes with the French position, which is fed by a more *heterogeneous conception* of lithic evidence (e.g., Tixier 1987 [2012]: 129; Soressi and Geneste 2011: 338-340, 342).[239] We have already seen that lithic parts are not necessarily treated equally there and some parts may not even be measured or properly recorded at all (see *supra*). When different assemblages are compared, the same object-characteristics do not always possess the same informational value. The French approach thus focuses from the beginning on the identification of evidential asymmetries and hierarchies (cf. Langlais 2010: 39; Perlès 2016: 232).[240] These have to be newly discovered in each assemblage, and cannot simply be inferred from the analysis of generic lithic data.[241] The reason is that

[238] A detailed account of UTF-analysis and its epistemological background is provided in the second part of Chapter 5.
[239] As we will see later, the clash between these two conceptions of evidence is a major source of epistemic friction and explains why 'objectivity' is such a contested notion. For Anglophone scholars, 'objectivity' is primarily secured through evidential equality, while in the French tradition it is safeguarded by argumentation and the assessment of intelligibility (both featuring more prominently in later stages of the research process) (see *infra*; Chapters 4 and 5).
[240] Cf. Plutniak (2015: 46f.).
[241] 'Analytic' research can of course also take into account class, trait, and attribute hierarchies but these are typically constructed according to some general rationale (e.g., 'set-theory' or the 'Theory of Types'; see Chapter 2). This rationale is applied to all

these hierarchies and non-similarity relationships are thought to be modulated by the assemblage-whole, and consequently cannot be detected by a strictly 'object-centred' approach. They are not so much 'outcomes' of individual object-characteristics, but the inevitable result of particular wholes administering particular parts. We will return to this issue in Chapter 5.

Importantly, only the Anglophone conception of evidence relies on a 'predefined input grid,' be it a generalised spreadsheet or a complex database (cf. e.g., Monigal 2002: Table 6-2; McPherron et al. 2018: 118).[242] The grid specifies what needs to be recorded and ensures that all examined artefacts are treated as equally as possible (or according to pre-defined rule-sets of an 'if x then y' type). Anglophone researchers typically invest a lot of time and space into providing a full list of the criteria they use and try to provide a general rationale which legitimises these criteria. French technologists, conversely, do in principle not depend on such input grids. Practically, however, they often use them. The critical point is that a grid, according French research logic, can only be constructed if one has already understood what is important in the assemblage and what can be shown by reference to particular artefact-characteristics. Input grids, therefore, tend to be technology- or assemblage-specific. Soressi and Geneste (2011: 340), for instance, also point out that in *chaîne opératoire* analysis "[...] a grid cannot be established before an initial global observation of the assemblage has been made; this is usually done with the assemblage organized on tables [...]." Input grids are therefore often used to explore highly specific consequences of particular whole-qualities, but French researchers remain generally sceptical about the explorative value of generalised spreadsheets and databases in establishing these qualities. Again, the reason is that their vision of lithic inquiry is 'synthetic' rather than 'analytic.'

What follows from all of this is that the artefacts themselves seem to play a differential role in French and Anglophone knowledge formation. From an Anglophone vantage point, lithic artefacts constitute the primary units of inquiry; they hold the totality of information required to set up a proper analysis, and they define both the starting point and the limits of an investigation. Artefacts can be data in themselves – as types, classes, or other categories – or they contain the relevant features, attributes, and traits to be transformed into continuous and discrete data points. It should be rather obvious that this conception of evidence lends itself to quantitative inquiry.[243] The result is that the evidential value of a lithic artefact is, *grosso modo*, determined by the nature of the same artefact. In French technological research, lithic artefacts may become data in more varied and less standardised ways. They assume the highest evidential value, however, if put into perspective by other artefacts, for example through grouping, sorting, or other forms of meaningful juxtaposition. The critical information about lithic assemblages, in other words, is carved out 'between' the lithic parts, not within them. This also means that key technological information always transcends the physical limits of the artefacts it concerns. Data, therefore, typically implicate multiple artefacts or entire configurations of such artefacts.[244] The artefacts themselves are only informative if they can successfully be calibrated against their assemblage-context. The result is that the evidential value of a lithic artefact is, *grosso modo*, determined by the assemblage in which it occurs (all other co-occurring artefacts).[245]

We are tempted to conclude that French lithic experts appear to underestimate the cognitive value of artefact-level features, whereas Anglophone scholars tend to undervalue assemblage-level characteristics. The French approach, on a general plane, is grounded in an 'emergentist' reading of the evidence insofar as it postulates qualities that are not fully reducible to the qualities of individual artefacts.[246] Anglophone modes of inquiry, by contrast, are 'reductionist' in orientation; they primarily seek to record the cumulative signatures of lithic parts and assume that assemblage-level qualities, if

---

lithic artefacts with the same rigour. Even hierarchies are therefore established 'democratically' (cf. e.g., Clarke 1968: 188, Fig. 40).

[242] For a prototypical example of a generalised lithic spreadsheet, see Garrard and Byrd (2013: Appendices C-H [402-410]).

[243] See Shennan (1997 [1988]) for an introduction. Most quantitative strategies rely on a 'bottom-up' approach to the evidence, locating data primarily in object-characteristics.

[244] French technologists seek to identify and describe 'techniques,' 'technical processes,' and other phenomena that concern more than a single artefact. Therefore, the data that is required to analyse them must point to the relatedness of artefacts rather than speak of their 'self-sufficient' qualities. Lithic data in French technological research consequently always reaches out to multiple co-occurring artefacts; the data that is carved out from an artefact must somehow implicate other artefacts.

[245] Conceptually, this comes close to asserting that lithic artefacts form part of a wider artefact-ecology and that their technical role or function can only be elucidated only by understanding this ecology.

[246] For insightful introductions to 'emergentism,' see Kauffman (1993) and Chalmers (2006).

they exist at all, can be directly deduced from artefact-level qualities.[247] This discrepancy has, without any question, considerable implications for the architecture of the divide and should have a strong impact on the potential findings and cognitive achievements of lithic analysis on both sides.

All of this demonstrates that the French-Anglophone divide seems to implicate a clash of 'synthetic' and 'analytic' modes of handling the lithic evidence on the most basic level. What is ultimately put at stake is, first, whether lithic parts can be said to fully explain their wholes or rather the other way around; and, secondly, whether lithic wholes have accessible characteristics that illuminate their parts in ways that they themselves cannot. The first issue is for example touched upon by 'reduction sequence' approaches which seek to model the 'stream of reduction' (*sensu* Henry 1989b) directly through dimensional artefact-level variations. The second issue plays an important role for instance in the definition of any given *« système technique »*, which is typically considered 'more' than an amalgamation of the artefacts it hosts (e.g., Geneste 1991; Valentin 1995: 25). The 'analytic'-'synthetic' polarity is therefore likely a major driver of conflict between Anglophone research, grounded in various kinds of 'attribute analysis' and 'dimensional analysis,'[248] and French *chaîne opératoire* studies, rooted in a 'synthetic' reading of the evidence.

The exposition has also indicated that a distinction between 'recording,' 'analysis,' and 'interpretation' is crucial for 'analytic' lithic research, whereas the boundaries between the three tend to be blurred by 'synthetic' approaches. For example, the examination suggests that Anglophone lithic inquiry records lithic objects by taking into account attribute-analytical demands. At this stage, however, the procedure is still purely descriptive. It is only with explicitly interpretive approaches – such as 'reduction sequence' (i.e., McPherron 1994; Dibble 1995b; Shott 2003, 2005b) or the 'Organization of Technology' (i.e., Kelly 1988; Nelson 1991; Carr and Bradburry 2011; McCall 2015: 93-95), sometimes grouped together as 'behavioural-strategic' (Shea 2013: 13f.) – that interpretation enters the arena of inquiry. This clearly seems to differ in the French case, where recording poses many interpretive challenges and requires scholars to move beyond what is immediately given through individual artefacts. *Chaîne opératoire* inquiry (i.e., Tixier 1980; Geneste 1985; Boëda 1986; Pelegrin et al. 1988; Pelegrin 1990; Inizan et al. 1995), as it seems, is already holistic in the sense of integrating key operations of data-construction and data-analysis into a single conceptual framework.[249] At any event, this is clearly an issue that needs to be clarified and part of the next section is dedicated to it. The issue puts the spotlight on questions of research design and the structural rules of argumentation and inference in lithic research.

3.2.2 ***Research design and the structure of inference***

What are the effects, if any, of the 'analytic'-'synthetic' divide on general aspects of research design and inference-making? This question concerns foremost the mode in which uncriticised observation is transformed into criticised knowledge claims. It also touches upon the direction of inference and has implications for the role of rationalisation and argumentation in the lithic research process. All of these questions, as Pepper elucidates (cf. Chapter 2), can only be answered with recourse to cognitive values, showing that 'analytic' and 'synthetic' inquiry support different normative theories of science. This is perhaps best reflected in the overall character of reasoning tied to either of the two. As clarified in the previous chapter, 'analytic' approaches commonly subscribe to 'formal-logical' modes of reasoning and argument, whereas 'synthetic' approaches tend to adopt 'dialectic-dialogical' modalities of the same. This distinction has important consequences for the structure of inference-making, a feature of lithic research that can be examined in some detail with the help of case studies.

[247] Some may counter that Anglophone research also musters assemblage-level qualities, most notably indices or other aggregate variables (i.e., the classic values 'IL,' 'IF,' 'IFs,' and 'Ilam'). While this observation is correct, these measures remain *fully reducible* to the artefacts in questions, meaning that they are directly inferable if one knows only the qualities of the individual artefacts on the basis of which they were constructed.

[248] See Ahler (1975) and Henry (1989b).

[249] This may mean that *chaîne opératoire* analysis relies on a logic of research, according to which a distinction between 'recording,' 'analysis,' and 'interpretation' plays a less important, perhaps even marginal role. In fact, this would not be particularly surprising given that *chaîne opératoire* approaches are likely underpinned by a 'synthetic' research paradigm (see *supra*). Distinguishing between 'recording,' 'analysis,' and 'interpretation' is, after all, a typical 'analytic' manoeuvre, assuming the research processes itself is analysable by well-defined parts. Because this assumption is not necessarily shared by 'synthetic' approaches, the research process may have a radically different character there (see the next section for an in-depth investigation).

'Analytic' cognition of the 'formal-logical' type organises research processes in such a way that the results seem to follow inevitably and 'automatically' from the data-input, given the accepted structural rules of cognition. This species of cognition is heavily driven by explicit methodologies which ensure the seamless digestion of evidence and control the pattern of reasoning. 'Analytic' inference therefore typically involves a high degree of formalisation, insists on maximally transparent deductions, and emphasises the directedness of inquiry. Argumentation primarily serves to guarantee that the transition from one stage of reasoning to another is really compulsory. The general structure of inference and argumentation is therefore well-defined and each operation, including argument, has a preordained function.

'Synthetic' cognition of the 'dialectic-dialogical' type, by contrast, is a more open-ended and multi-stranded endeavour; it rejects the idea of a fixed and somewhat stable structure of cognition. The solutions to cognitive problems are thought to be problem-specific and no general cognitive formulae can therefore be established. Inference in 'synthetic' research is always a struggle and multi-directional. The progression of reasoning is less rigorous and the evaluation of arguments is less straightforward since each argument needs to be evaluated contextually. This puts an even heavier burden on *rationalisation* and *argumentation* because only they can ensure that the cognitive constructions withstand further scrutiny.[250] The general structure of inference is therefore extremely flexible and favours more complex patterns of reasoning. Analysis and argumentation become a question of cross-adjustment – to arrange all parts in such a way that they satisfy their whole(s). Reasoning is less guided by formal-logical models and is conceptualised as multi-layered exchange of *pros* and *cons*. In *Méthode pour l'étude des outillages lithiques*, Tixier (2012 [1978]: 122) himself notes that there is a "dialogue which takes place between a prehistorian and flint." According to the 'synthetic' standpoint, it is this dialogue which delivers insights that can be carried over into robust lithic knowledge claims.

These general differences may already explain some of the recurrent kinds of criticism which are observable at the French-Anglophone interface (see Chapter 1). Given the outlined polarities, it is, for instance, no surprise that French lithic inquiry is often stigmatised as overly 'subjective,' 'intractable,' and 'non-reproducible.' Anglophone approaches, on the other hand, are unsurprisingly perceived as 'corset-like' and as giving voice to a 'tyranny of procedure,' in which methods often legislate over empirical data. Taking up again the insights from the previous chapter, this configuration is likely the result of a differential understanding of key conceptual coordinates such as 'objectivity' and 'rationality,' and may indicate that 'method' does a differential work in the two larger research frameworks, being designed to secure vastly different epistemological qualities.

The same differences, moreover, can clearly be recovered if we delve deeper into the three cases of interpretive conflict introduced in the second part of Chapter 1 (Biache Saint-Vaast IIA, Gouzeaucourt G, Micoquian layers of Kulna). A closer look into the adopted patterns of reasoning, the interaction between the construction of hypotheses and the mobilisation of data and methods, as well as the general progression of argument, including the logic of connecting different findings, confirms that the respective French authors (Boëda, Soriano) adhere to a 'synthetic' architecture of thought, whereas the involved Anglophone scholars (Dibble, McPherron, Tostevin) closely follow 'analytic' schemes of reasoning.

The latter group has authored highly-ordered, simplicity-favouring structures of inference, exhibiting a high-degree of inferential and argumentative redundancy (**Fig. 3**; see **Appendix III.1** for additional reconstructions and an explanation of the rationale guiding the conceptual analysis). The basic character of this pattern is that the analysis follows a semi-automated algorithm, resulting in a high degree of structural similarity between the approaches. Tostevin's (2012) comparative study of the Kulna lithic material slightly deviates from this pattern, but only with regards to the complexity and scope of analysis.[251] The reconstructed architectures of analysis clearly situate Anglophone lithic inquiry within a spectrum of approaches deploying 'inductive' and 'deductive' modes of reasoning in order to test explicitly formulated hypotheses. Even though both Dibble's (1995a) and McPherron's

[250] Cf. esp. Perlès (2016: 225).

[251] This finding only corroborates that the internal variability of 'analytic' lithic approaches should not be underestimated. In fact, Tostevin's (2012) more complex 'tree of analysis' (see **Appendix III.1: Figure III.3**) indicates that his investigation actively pursues the *proliferation* of fact and, accordingly, 'goes wide' in data-collection and -analysis. Together with a comparatively 'defused' hypothesis-testing approach and the generality of the finally offered explanations, this suggests that Tostevin's study responds to a broadly 'formistic' logic.

(1994) investigations are governed by a 'hypothetico-deductive' structure of reasoning, all three studies exhibit some degree of mixture between 'inductive' and 'deductive' inference-types. The key point is that the analysis is generally well-focused and directed, and that the evidence passes through a number of pre-defined stages of analysis before a knowledge claim is formulated. As a result, constructing the general theoretical framework from which the hypotheses are derived as well as specifying their test-implications structurally *precede* empirical data evaluation (cf. Clark 1991a). Basically, the 'rational' side of research, general theorisation and hypothesis-building, is well-separated from the 'empirical' task of data-analysis.[252] This bifurcation results in a well-ordered structure of inference, in which different operations serve their purpose within a specific, but largely generic chronological sequence (cf. Hill 1972).

Conceptualising rationalisation as a 'pre-empirical' procedure is important since it leads to a distinct character of arguments depending on whether they are used to develop theory and hypotheses or whether they serve to assess the degree of support the latter experience by the data. The evaluation of the actual 'match' between hypotheses and data is highly standardised, rooted in formal-logical calculus, and in all three cases heavily relies on statistical methods – it becomes a cognitive 'routine':

> "[...] the word *analytical* [...] refers to the more general philosophical principle of using formal empirical observations in the building and testing of hypotheses. "Formal" in this instance refers to the use of quantitative data (be it categorical, ordinal or metric), to assess in a detailed manner the relationship (or otherwise) between a set of empirical phenomena and a particular model or hypothesis derived from theory or observation, the assumptions and predictions of which are made explicit. Such an approach can be contrasted with those of description and narrative." (Lycett and Chauhan 2010b: 3; original emphasis)

In general, the specific research designs and patterns of inference embraced by the Anglophone lithic researchers are clearly of an 'analytic' type. The structural exposition of reasoning reveals that they are either 'Hempelian' and therefore strongly influenced by the 'covering-law' model of scientific explanation (cf. e.g., Salmon 1967)[253] or at least subscribe to the basic principles of 'verificationism' and 'falsificationism.'[254] The distinction between 'empirical' and 'theoretical' operations thereby regulates the progression and logic of inference.[255] Because lithic inquiry in these cases is really hypothesis-driven, the structure of reasoning is that of a 'fork.' Typically, this means that a number of competing hypotheses is first outlined and then compared *independently* against the data. This strategy authors multiple individualised and largely self-contained pathways of inference, which only in the final stages of analysis contribute to the formation of knowledge claims. Again, this pattern is genuinely 'analytic' since different hypotheses or domains of inquiry (e.g., 'knapping domains' in the case of Tostevin's study) make up the 'parts' of the analysis which, through individual interrogation, allow for a synthesis of parts that clears the view for the 'whole.' In this scenario, the whole is nothing else then the outcome of analysis.

However, in a strictly hypothesis-testing approach, each hypothesis itself also defines a possible whole; the analysis simply checks whether the whole actually follows from the recorded parts (i.e.,

---

[252] This separation closely follows the 'two context' conception of science advocated by Reichenbach (1938) and many other Logical Empiricists, but also by Popper (1965). The basic assumption of this distinction is that there exists a *general logic* of scientific justification, but no such general logic of scientific discovery. Accordingly, the logic of science becomes congruent with the 'scientific method.' Differentiating between the 'context of discovery' and the 'context of justification' typically implies to regard the construction of hypotheses and theories as creative acts which are by definition idiosyncratic and somewhat 'psychological.' This view, now deeply entrenched in many branches of science, conceives of the 'context of discovery' as an *exogenous* factor in scientific practice (cf. Nickles 2013).

[253] The perhaps most important account of the 'covering-law' model of explanation was provided by Hempel and Oppenheim (1948; see also Hempel 1942, 1945, 1965). This model of explanation takes up the idea that explanation requires one to show *how the explanation derives in a logical argument*. The 'covering-law' model adds that the premises of that logical argument must entail at least a single well-confirmed *law* or *regularity* of nature (cf. Godfrey-Smith 2003: 191). These must make a substantial contribution to the argument. Part of the motivation to introduce this model of explanation was to allow for the possibility of good 'inductive' arguments. In general, 'covering-law' explanations explain by showing that the *explanandum* (whatever is to be explained) was to be *expected*, that is, was no 'surprise,' given our knowledge about the basic regularities of nature.

[254] See Ayer (1936) for an influential theory of 'verification,' and Popper (1965, 1968) for an influential account of 'falsification.' Note that these accounts are 'analytic' insofar as the process of corroboration targets observational parts and compares them against the 'theoretical expectations' of a hypothesis (conceived of as the whole to 'end up with'). The corroborative procedure is *hypothesis-driven* and each hypothesis is considered to be testable independently.

[255] Note that this is precisely the concept of scientificity that was deliberately adopted and fiercely defended by Lewis Binford (1972, 1977, 1982) and the *New Archaeology* from the 1960s onwards (Spaulding 1968; Watson et al. 1984; cf. Trigger 2003: 9). The general 'mechanistic' orientation that the conceptual distinction between 'observational' and 'theoretical' implies is discussed in Chapter 2.

the available evidence) or not. Another facet of the same research logic is that a bigger problem, for example the reconstruction of lithic reduction dynamics, is broken down into a number of sub-problems, each investigated separately. This strategy is employed in all three Anglophone cases. It reveals a compositional structure of reasoning and shows that the 'compartmentalisation' of cognitive problems is an Anglophone hallmark. The basic strategy is 'anti-holistic' and presupposes the primacy of parts. 'Epistemological atomism' or 'methodological individualism' (see Chapter 2) are some of the common symptoms of this 'analytic' mode of lithic cognition. Binford's (2015 [1972]: 111) account of data-explication, for instance, provides a useful illustration here:[256]

> "Explication generally refers to some systematic description of observations. In this the archaeologist faces the task of breaking down a whole into parts, generally with the aim of elucidating its componential make-up, and the interrelationships among its components."

Although Tostevin's (2000, 2012) examination of the Late Middle Palaeolithic layers of Kulna cave, as noted earlier, seems to deviate from the generally deductive mode of inference employed by Dibble and McPherron, it nevertheless subscribes to explicit hypothesis testing, the primacy of theory in the construction of the research framework, and the maximally rigid evaluation of logically distinct relationships between 'theoretical' claims and 'empirical' evidence. A central goal, just like in the other two Anglophone cases, is to maximise *inferential transparency*. This is not only ensured through the *grosso modo* linear and well-defined structure of inference itself, but also through the application of highly standardised (statistical) procedures to compare expectations and findings. Inferential transparency is valued because it promises to assure a basic 'objectivity' of research, which, again, is thought to be indispensable for guaranteeing the 'replicability' and 'subject-independency' of inferences and conclusion (cf. Binford 1982; Marwick 2017). We will come back to the issue of subjects later in this section. What is perhaps most important is the structural rigidity exhibited by this approach. This rigidity leads to a high degree of operational redundancy, with different types of evidence handled in broadly similar terms.

Tostevin's *Seeing Lithics* (2012), just like McPherron's (1994) examination of bifacial shape-variability, further demonstrates that comparability among assemblages is primarily ensured by treating them *similarly*.[257] The resulting highly uniform analytical procedure facilitates one-to-one juxtapositions and makes sure that the exact same type of information is available for all of the studied assemblages. This, of course, clearly attests to an 'analytic' research orientation since the direct (i.e., unmediated) comparison of assemblage-parts in order to assess questions of similarity and difference on the level of assemblage-wholes only makes sense in an 'analytic' framework of inquiry. Since parts, from a 'synthetic' perspective, cannot stand for themselves, they also cannot be compared directly without knowing what their position, role, or function in a 'whole' is. At any rate, the epistemological 'principle of equality,' already encountered on the level of data-construction, seems to also apply to general questions of research design.

A final, yet important characteristic of the three Anglophone cases is that an explicit interpretation of findings is only offered *after* formal hypothesis-testing. All examined patterns of reasoning therefore evince a three-part structure, with a clear separation between theorisation and construction of hypotheses, primary data-analysis, and final data-interpretation.[258] The three parts are held together by a methodological framework. Typically, this general logic of inquiry is already signalled by the succession of headings and subheading that structure the papers, chapters, or books in which lithic research is reported. After outlining the general debate and the relevant research questions, these commonly describe the theoretical background of the taken approach and then introduce the methodology that is thought to help answering the research questions given the theoretical enumerations.

[256] Note that the mere distinction between 'exploration,' 'explication,' and 'explanation' as suggested by Binford (1972b: 110) already indicates an 'analytic' approach. The well-differentiated role of these analytic 'activities' and their well-defined position within the sequence of reasoning supports this conclusion.
[257] This level of structural formalisation is of key importance for the nature of employed argumentative strategies. Only if highly formalised patterns of reasoning are employed is it possible to assess and criticise each single finding in the same way. The same basic arguments can then be mobilised again and again to inform the final conclusions. Therefore, structural and operational redundancy in this sense typically foreshadow argumentative and inferential redundancy. In the extreme case, examinations of this type appear to be driven by a 'cognitive machinery' whose results are inevitable and leave little leeway for interpretive creativity. Of course, it is precisely this general quality of scientific cognition that is deemed to be most 'reliable' by adepts of 'analytic' thought.
[258] Cf. e.g., Clarke (1972b).

Only then is the data introduced and analysed according to the selected methodology. The results are presented in a 'result' section. This section is usually kept separate from a 'conclusions' section in which the respective findings are placed into the larger debate and reflected upon in light of the chosen theoretical perspective. This general structure has in fact already become the norm in many of the field's leading peer-review journals, and has numerously been reiterated by various FAQs of 'how to write a scientific paper.' It can be found, for instance, in the guidelines of journals such as the *Journal of Human Evolution*, the *Journal of Archaeological Science*, and *PLoS ONE*. These are clearly 'analytic' journals, responding to the standards of inquiry which have been cultivated in the Anglophone research sphere.

In total, it is thus perhaps no surprise that Anglophone researchers increasingly identify themselves as *analytic* scholars (cf. Shennan 2004).[259] This general orientation of research was of course already addressed by David Clarke's epochal *Analytical Archaeology* (1968) and actively propagated by leading 'New' Archaeologists such as Lewis Binford. Within the same breadth, one could also mention the contributions of Glynn Isaac (1989) and many others. More recent Anglophone volumes that address theory and method in lithic research, for example *New Perspectives on Old Stones: Analytical Approaches to Palaeolithic Technologies* (Lycett and Chauhan 2010a), follow the same research trajectory.[260] In this light, it is probably uncontroversial to suppose that the vast majority of Anglophone scholars tends to conduct 'analytic' lithic research.

How does this compare to the examined French cases of lithic inquiry? Perhaps most importantly, there is no standardisation of the research process itself. Modes of argumentation and the followed pathways of inquiry, as a consequence, differ dramatically between the three cases. The main reason is that basic operations of inference are thought to be *case-sensitive*. Although the applied terminology and concepts are broadly shared, the way in which they are brought to bear varies. This suggests that the evidence itself exercises a much greater impact on how lithic inquiry is precisely done, including its direction and progression. A close inspection of the three French case studies (i.e., Boëda 1988, 1995a; Soriano 2000) in terms of research design and structure of inference further demonstrate that they violate key principles of 'analytic' thought, blurring the boundaries between some of the categorical distinctions that structure the research process there. The French cases, for instance, reject the structural and logical separation between 'rationalisation' and 'empirical corroboration' – the old Reichenbachian polarity between the 'context of discovery' and the 'context of justification' which has become a hallmark of 'analytic' inquiry (see *supra*). A tangible consequence of this repudiation is that a procedural and research-logical differentiation between hypothesis-construction and hypothesis-testing is no longer regarded to be effective. Rather than being independent operations that follow up on each other in a pre-defined temporal sequence, both form complementary parts of the process of data-analysis. Even hypothesis-construction therefore relies on a direct contact with the lithic evidence.

Boëda's (1988) approach to the lithic material from Biache Saint-Vaast level IIA illustrates this general condition. Here, the process of inference becomes manifest as a *cyclic structure*. We can identify multiple cycles and sub-cycles of hypothesis-formation, -evaluation, -rejection, and -reformulation, and these cycles are clearly embedded in primary data-analysis.[261] This process, as the comparison with the other French cases demonstrates, lacks structural formalisation. The analysis is driven not so much by formal-logical reasoning or inferential statistics, but is powered by *qualitative* arguments that seek to establish an interpretive 'dialogue' with the source material and between different parts of the source material (e.g., Boëda et al. 2013a: 194). The arguments are fashioned in such a way that they can be answered *relationally*, that is, with regards to other artefacts or already established assemblage-level findings supporting or disapproving particular readings. The result is a multilinear configuration of reasoning.

[259] See also Lycett and Shennan (2018).

[260] See esp. Gowlett (2010) and O'Brien (2010) in the same volume.

[261] Many French scholars have characterised their approach as relying on an 'inductive method' (e.g., Tixier 2012 [1978]: 125; Bon 2009: 120). As I try to show here, however, this is only adequate insofar as French technological research departs from the lithic facts and only from there develops theories and hypothesis. The procedure is not really 'inductive' in the strict sense because the inferential core is not so much based on formal or informal logic, but rather on *interpretation* (see *infra*). For clear rejection of the cognitive significance of the 'inductivism-deductivism debate' in French archaeology, see also Cleuziou et al. (1991).

In contrast to their 'analytic' counterparts, however, the resulting strands of analysis – individual cycles and sub-cycles – are critically *dependent* on one another. Their role is to focus and guide the analysis, not to deliver self-sufficient findings. These strands, in other words, have no independent say, but only through interaction, protrusion, and overlap with other strands provide insights into the lithic assemblage; they cross-configure each other in what they can contribute to the process of knowledge formation. The structure of reasoning, therefore, is generally elastic. There is a constant argumentative and inferential 'back and forth' between the constitutive elements of an individual cycle of reasoning, but also between all of the relevant cycles themselves. The analysis is holistic to this effect; no individualised strand of inquiry has significance without being responsive to the totality of significant strands. This is the 'synthetic' quality of Boëda's approach. The 'wholeness' of the account exercises authority over the 'partness' of localised findings and assertions.

An important consequence of this logic of analysis is that there is no 'natural' or 'logical' point of inferential departure. Where one starts the investigation – that is, what one studies first and what considerations one decides to throw into the mix first – does not really matter much. The reason is that anything which is said or argued needs to meet the standards of the whole, and this whole consists of the coming together of *all* parts. French lithic inquiry therefore comes into view again as a constant and highly dynamic cross-adjustment of parts and wholes. The point is that there is no necessity to start with the examination of a particular object class or to present individual findings in a particular order because they all need to be adapted to each other anyways. As a result, inferential pathways tend to be extremely *heterogeneous* and generally depend on the quality of the assemblage-whole. Some scholars chose to open up the investigation with an assessment of the core-technology, some opt for an assessment of the *débitage* first, and others, although this is more rarely encountered, start with a discussion of the toolkit.[262] The main reason for why there is a sequence at all is that one cannot, practically speaking, present all of these aspects at the same time. Much of the actual multi-linearity of reasoning that underlies French technological inquiry is masked by the constraints of producing a readable and legible paper.

These elucidations suggest that an important structural difference between 'analytic' and 'synthetic' reasoning at the French-Anglophone boundary is that the former shelters structural uniformity and cherishes general argumentative rule-sets, whereas the latter makes room for much more structural diversity and incentivises scholars to creatively devise case-specific arguments.[263] I would contend that this polarity leads to a critical trade-off: the Anglophone research structure, because of its separation between handling 'theory' and 'data,' encourages practitioners to diversify their theoretical repertoires and develop them independently; in the French case, creative diversification takes primarily place within data-analysis itself, leaving 'theory' behind as a somewhat problematic and mostly implicit dimension of research. We will return to these issues in the next section.

The cyclic structure of inference that seems to characterise French lithic inquiry is perhaps best reflected in the reconstruction of core-blank technologies. Again, Boëda's (1988) analysis of Biache-Saint Vaast IIA is a useful example here. In order to understand the signification of core variability, he examines the 'stigmas' of the cores and compares their spatiotemporal organisation with the technical features of the blank-population.[264] The goal is to determine groups of cores and groups of blanks which endow each other with meaning, and thus define a technological unit. The clue of this

[262] In practice, French practitioners often start the investigation with a detailed treatment of cores. This, however, has no structural or epistemological reasons, but simply responds to the fact that there is an asymmetry between cores and their flaking products. There are always multiple *débitage* products that 'belong' to a single core. This situation renders cores potentially richer in referencing other lithic objects in the assemblage; they are more pregnant in implicating other artefacts. This is why it is typically practical to begin with an analysis of cores rather than other types of lithic objects. In fact, however, this reasoning only underlines that there can be no 'natural' entry point of analysis. If cores are only chosen because of the many other artefacts they reference, this simply shows that no single artefact, not even cores, can be discussed in isolation and that it really doesn't matter where one starts – simply because one always has to discuss all lithic artefacts in light of their *entire* assemblage-context.
[263] According to a 'synthetic' understanding of science, heterogeneity tends to be regarded as an 'epistemic virtue.' It is usually highly valued among practitioners. For example, argumentative and inferential 'originality,' 'sophistication,' and/or 'elegance' typically carry positive connotations and scholars seek to realise them through their work. While 'analytic' approaches typically try to secure an epistemic 'democracy' by treating lithic objects in a similar fashion, 'synthetic' approaches instead value epistemic heterogeneity because it gives voice to the 'democratic freedom' of plural readings. In fact, analytical heterogeneity – the antithesis of epistemic rigidity and uniformity – can be viewed as a *precondition* for general intellectual creativity that is not restricted to methodological or theoretical innovation alone. The 'synthetic' understanding of scholarly 'ingenuity' is likely rooted is this valorisation.
[264] To be perfectly clear, the mobilisation of the term 'stigma' is not at all idiosyncratic here (cf. e.g. Inizan 1995: 25, 29, 34-36, 59, 73, etc.).

analysis is that the artefact features and their combination encountered in one artefact-domain are calibrated against the features in the other domain in order to isolate patterns of co-constitution. Only if most characteristics in the two artefact-domains can be shown to co-constrain each other – that is, to make sense in light of each other – can it be concluded that the two domains are also technologically related. This analysis also entails the necessity to show that the determined relationships help to resolve the entirety of the present lithic artefacts in a meaningful way.

Already the term 'stigma' implies this mutualistic logic of analysis. Technical 'stigmas,' in the sense of Boëda and others, are not just individual traits that leave a physical mark on their lithic objects. Stigmas are relational units of identification and generally refer to configurations of entities. A stigma on an object therefore already implies other objects. Goffman (1963, 1974), for example, who provided one of the most influential characterisations of the concept to date, defines a 'stigma' as the status of a person as assigned to that person by other persons in that person's social field. Processes of 'stigmatisation,' according to Goffman, are therefore sociologically significant. They tell us something about the position of the person in her/his social field. Analogously, technical stigmas tell us something about the status of a technical object *as assigned by other objects* in that object's technological field. The 'technological field' thereby simply refers to the technical 'sub-whole' to which the stigmatised object contributes (i.e., a particular core-blank technology, a technical structure, a technical system). An analysis of technical stigmas, conversely, allows one to determine which other lithic objects in the assemblage are relevant for the explanation of the stigmatised object.[265] We can conclude that a technical stigma, according to Boëda, is *technologically significant*; stigmas are qualities that reference other qualities and thus always encapsulate 'more-than-the-stigmatised-artefact.' Stigmas, in other words, 'reach out' to the assemblage context. The mobilisation of the notion of a technical 'stigma' is consequently indicative of the anti-atomistic orientation of French lithic analysis.[266] It clearly testifies to a 'synthetic' approach to the lithic evidence.

Boëda's (1988) reconstruction of the various core reduction methods, including unidirectional and bidirectional 'Levallois recurrent' (*Schéma A*, *B*), is therefore comprehensible as a continuous inferential movement 'back and forth' between varying lithic parts and their potential lithic wholes, in the process of which both are mutually adjusted to each other until global intelligibility is reached. This pattern of reasoning is 'dialectical' at its core. It clarifies what it means to 'bring the lithic artefacts into dialogue.' We may then also better understand why the process of reasoning itself tends to be of a 'dialogical' nature. The interrogation of, say, a core leads to an initial interpretation, which suggests a set of possibly related artefacts; the interrogation of this set, in turn, may confirm the initial interpretation or, more likely, leads to new interpretive perspectives on the core. It may of course also lead to a re-adjustment of the initial interpretation. Typically, the initial confrontation of potentially meaningful artefact-subsets of an assemblage leads to new strands of investigations pertaining to all subsets, often resulting in a reshuffling of at least some of these sets.[267] In the extreme, re-adjusting an interpretive claim therefore requires one to also adjust all connected assertive claims. This inferential cyclicality, which is open-ended, results in a basic condition of *holistic testing*.[268] Interpretations cannot be evaluated individually, but rise and fall as a function of the total set of currently held interpretations. To 'test' a single inference thus always means to test the entirety of current inferences. If intelligibility cannot be reached, the inquiry must start anew. It should be clear that a publication conveys on the final and ultimately successful pathway of reasoning.

---

[265] The concept of a 'technical stigma' therefore already expresses the aspiration to arrange lithic assemblages, understood as 'wholes,' into various 'sub-wholes' in order to illuminate the role and status of each single lithic artefact therein.

[266] The point is that a 'technical stigma' defined in this way usually implicates technical relationships which are not based merely on (dis-)similarity. Rather, the sought-for relationships – those that can be defined as *technical* in the strict sense – are typically based on *complementarity* and *transience*. A 'transient tie' describes a technical relationship between two or more lithic objects or processes involving no direct interaction, but some 'intermediator(s).' Such *indirect relationships* are generally difficult to track by 'analytic' inquiry, especially if the guiding root metaphor is 'similarity.'

[267] This interpretive 'sorting' includes the possibility of rejecting the explanatory relevance of particular groups of artefacts for other groups of artefacts, and *vice versa*.

[268] 'Methodological holism' has been prominently defended by thinkers such as Pierre Duhem and Willard O. Quine. In epistemological terms, the key idea is that the *whole* of a theory or an entire set of propositions is the *smallest unit of confirmation*. Quine (1951b: 42) even posited that "[t]he unit of empirical signification is the whole of science." An important consequence of this view is that a failed prediction does not necessarily refute the hypothesis on which it was based. The point is that the confirmation of a hypothesis always depends on more general background information and the relationship of the hypothesis to other hypotheses. In holistic modes of inquiry, therefore, a hypothesis typically loses both its status as the smallest unit of confirmation and its epistemological independence.

We have already seen that the general character of 'synthetic' cognition is open-ended and that 'synthetic' modes of argumentation typically embrace the lurking incompleteness of their knowledge claims. This, again, is linked to the cyclic nature of inquiry and its weakly defined structure and directionality. Because argumentation and rationalisation are 'dialogical' and serve primarily to connect disparate pieces of knowledge, they cannot settle a problem once and forever. In 'synthetic' science, whole-part dynamics are always puzzling, delivering a vision of scientificity that emphasises ongoing effort rather than the fruits of knowledge. It can be argued that this general cognitive orientation is directly reflected in a 'rhetoric of provisional results.' This rhetoric not only rejects ultimate answers to thorny questions,[269] but also motivates a practice in which preliminary syntheses are flagged by denominations such as *« essai »* ('essay') and *« jalon »* ('milestone'). These terms are used to name books, chapters, and papers, and thus denote a central mode of reporting the interconnection of certain findings. They are rather omnipresent in the French expert literature, especially in more recent instantiations (cf. e.g., Leroi-Gourhan and Brézillon 1972; Schmider 1988; Pigeot et al. 1991; Valentin 2008a: 47; Mevel 2017: 253ff.). In Anglophone research, by contrast, such terms tend to be shunned because of their undesired 'narrative' connotations (cf. Binford 1968c: 11; Lycett and Chauhan 2010b: 3 [op. cit.]; Shea 2013a: 295).[270]

We have also seen that French lithic inquiry is really the product of an interpretative tradition of stone artefact analysis. 'Interpretation' is thereby not just a question of giving a final verdict after data-analysis has been conducted, but plays a role on almost all stages and levels of the research process. Each 'act' of re-organising one's judgements after a cycle of inter-artefact confrontation has been passed through involves at least a single interpretive decision. In practice, this often blurs the second stronghold of 'analytic' rigidity: the structural distinction between 'observation' and 'interpretation.'[271] Furthermore, interpretation is a key operation since it helps to bridge parts and wholes and to navigate through the unsteady cycle of inference.[272] This 'dialectic-dialogical' pattern of reasoning supports a *hermeneutic* logic of inquiry,[273] in which the emphasis clearly lies on 'understanding' [*Verstehen*] rather than 'explanation' [*Erklären*] (cf. e.g., Von Wright 1971; Schurz 1988; Corbey 2005: 122-134). 'Understanding,' as defined here, can be recognised as a species of knowledge which centres on 'piecing together disparate pieces of knowledge' (e.g., de Regt and Dieks 2005; de Regt 2009; Gijsbers

[269] A clear symptom of this 'open-endedness' of inquiry is the presence of many explicitly formulated questions within the interpretative part of research. An example is Marchand's (2014) attempt to bring together various lines of investigation in order to understand the historical trajectory from the Late Palaeolithic to the Neolithic in Brittany. His account is extremely 'thick' and puts forth many unanswered questions while trying to connect the various pieces of evidence he has collected.

[270] Even though such small details should perhaps not be over-interpreted, they show that French attempts to endow a historical sense to *apriori* isolated observations often leads to quasi-narrative procedures (e.g., Valentin 2008a; Bon 2009), imposing a certain 'textuality' onto the palaeo-archaeological record (cf. de Beaune 2016: Chapitre VIII, 279-282). I would not go so far as to infer that this already exposes a tacit reliance on the idea of 'material culture as text,' but it certainly transports a hermeneutic undertone. It at least seems to be no coincidence that 'textuality' has been a key term for many French post-structuralists (as they are labelled in the Anglophone world; for a critique of the term from a French perspective, see Angermuller 2015). Propelled by what is sometimes called the 'linguistic turn,' these scholars began to re-conceptualise texts in the most abstract sense *as by necessity incomplete entities*. A text in this sense is always partially 'hidden.' This incompleteness was then regarded as the main obstacle for 'understanding,' therefore requiring specific interpretive procedures to be successful. Narration is one such procedure of holistically making sense of textual incompleteness. For French *« Paléohistoire »*, the analogy seems particularly striking since the Palaeolithic record also presents itself as an inherently fragmentary and 'dis-membered' object of study.

[271] Admittedly, the key point here is not only how 'synthetic' science makes sense of the distinction between 'observation' and 'interpretation,' but also what can *count* as either of the two. Pepper (1942: 48) clearly anticipates this problem. According to Pepper (*ibid*.: 100), what can count as 'pure' fact may vary dramatically among world theories. It is therefore likely that some of the 'pure' facts of French technological research are regarded as 'highly interpreted facts' by Anglophone analysts. Although Pepper (*ibid*.: 51) notes that within world hypotheses 'data' are typically refined in such a way that their 'purity' can be defended, they nonetheless tend to be 'loaded with interpretation.' We will return to this issue in Chapter 6.

[272] Valentin (2005: 148), for instance, explicitly calls for a more 'interpretive ambition' in devising artefact typologies. These typologies are not just required to say something substantial about the lithic objects themselves, but have to 'restore the place of the facts in the respective technical system.' These 'interpretive typologies,' in other words, have to serve the technical wholes under consideration. For a detailed discussion of the role of typologisation in French technological research, see the first part of Chapter 5.

[273] In the context of hermeneutic understanding, the cyclic structure of inference is mirrored by what is widely known as *the hermeneutic circle* (cf. Bolten 1985). With Norris (2005), one can say that the latter is concerned with "the fact that comprehension can only come about through a tacit foreknowledge that alerts us to salient features of the [objects of study] which would otherwise escape notice. Yet it is also the case that every [object of study] (and every reading of it) in some way manages to pass beyond the 'horizon of intelligibility' that makes up this background of foregone interpretative assumptions. The debate is joined between those (like Gadamer) who think of understanding in terms of a dialogue or ongoing cultural conversation, and those – Habermas among them – who wish to maintain a more independent role for the exercise of critical thought." Hermeneutic reasoning, accordingly, typically bespeaks of a mode of argumentation that I have characterised as 'dialectic-dialogical' (see Chapter 2 for a discussion of hermeneutics and general 'synthetic' argumentation).

2013) rather than proceeding from a well-defined set of premises to the conclusions in a controlled, directed, and broadly pre-conceived formal-logical manner (e.g., Trout 2007).[274]

All of this suggests that French lithic inquiry, in contrast to the vast majority of Anglophone lithic research, is neither governed by 'deductive' nor by strictly 'inductive' modes of reasoning – both of these species of cognition are 'analytic' insofar as they presuppose that parts are the primary units of analysis and, after careful examination and comparison with other parts, directly result in the sought-after wholes. Instead, French approaches seem to be based on a cognitive strategy in which the *coordination* of parts and wholes is essential. In this strategy, overarching directions or generic patterns of inference cannot be predicated. The lithic evidence tends to be handled 'bottom-up' and 'top-down' at the same time: French technologists analyse lithic parts in order to grasp possible wholes and whole-characteristics, but they similarly examine whole-qualities in order to better understand the signification of parts. Nonetheless, the primary points of reference are always whole-categories since they ultimately legislate over the interpretation of the lithic parts. The result is a 'looping' quality of reasoning in which the level of analysis constantly shifts between parts and wholes, both being subjected to an ongoing process of re-definition and mutual adjustment. We may therefore perhaps more adequately term this mode of reasoning 'transductive.'[275]

Altogether, the examination of the three pairs of assemblage-based case studies in terms of research design and structure of inference has demonstrated that the 'analytic'-'synthetic' polarity plays an important role in organising the French-Anglophone divide. It seems clear that French lithic inquiry is founded on broadly 'synthetic' premises, whereas Anglophone lithic research is imbued with an 'analytic' understanding of science. The identified structures and morphologies of lithic reasoning, but also the nature and role of the mobilised arguments support this view. Some of these differences appear to resonate with the classic distinction between 'explanation-based' and 'understanding-based' projects of research. This is certainly interesting since French and Anglophone approaches, for this reason alone, may then be differentially capable to harness the cognitive resources of particular cognate disciplines. The very definition of a 'cognate' discipline may in fact vary because of it. [276] This, in turn, might at least partly explain why Anglophone research endeavours are often strongly influenced by the natural and life sciences, whereas French technological research tends to draw more heavily on the interpretive branches of the humanities and social sciences[277]. This split, moreover, seems to partly run in parallel with the well-recognised separation between 'analytic' and 'Continental' strands of philosophy and their corresponding conceptions of scientificity (cf. e.g., Friedman 2000; Levy 2003; Chase and Reynolds 2010). The 'parting of ways' between French and Anglophone lithic inquiry is therefore likely to reflect the relative position of the two in the wider landscape of Western intellectuality.

Lastly, the distinction between 'analytic' and 'synthetic' science, but even more so the conflict between 'explanation-based' and 'understanding-based' approaches, implies a deep-running discord of the status of the human subject in the quest for lithic knowledge. We have already touched upon this issue in the context of 'uniformity'-'heterogeneity' trade-offs pertaining to the structure and logic of reasoning at the French-Anglophone interface. While 'analytic' research in the 'explanatory' mode usually promotes an 'objectivist' conception of lithic knowledge and thus seeks to eliminate or at least minimise the human factor, 'synthetic' approaches in the 'understanding' mode tend to crucially rely on human judgement and interpretation. The latter consciously exploit the ineluctable 'horizon' of human subjectivity in order to grasp the complexity of lithic realities.[278] The implied view of science emphasises the irreducibility of human involvement in processes of inquiry, re-casting the human

[274] Proponents of 'nomothetic' conceptions of science, those who want to give an 'objectivist' account of scientificity, have typically conceived of 'understanding' and 'intelligibility' in rather pragmatic terms, potentially varying from person to person and context to context. This status that is of course at odds with the 'universalist' aspiration of 'objective' research in these circles (see e.g., Hempel 1965: 413, 425f.).

[275] See **Appendix III.2** for a schematic comparison of 'transductive' and 'inductive'-'deductive' modes of reasoning.

[276] A detailed account of the relevant extra-disciplinary resources in French and Anglophone lithic research will be given in Chapters 4 and 5.

[277] See e.g. Betti (1962) for a classic attempt to ground all of the humanities [*Geisteswissenschaften*] in hermeneutic method and reasoning. Classic hermeneutic perspectives have been provided by Habermas, Ricoeur (for philosophy), Weber, Oevermann (for sociology), Geertz (for interpretive ethnology), Dilthey, and Rickert (for historiography and history). For a more general discussion including the potential role of the 'hermeneutic mode of reasoning' in 'synthetic' inference and corroboration, see Chapter 2.

[278] For a conceptual account of this inclination, see de Regt (2014: 379).

factor as an enabling condition of knowledge production. Each researcher's subjective background of knowledge – her/his 'hermeneutic horizon' – is considered an interpretive asset rather than something that potentially hinders insight. Understanding, in this view, critically depends on various forms of *pre-understanding*.

The perhaps most obvious example in French lithic inquiry is the role of knapping experience and the importance of knowledge about fracture mechanics, including an understanding of general principles of convexity management (cf. Pelegrin 2006b: 40; Perlès 2016: 225).[279] These axes of pre-understanding are indispensable for evaluating how wholes and parts co-constrain each other and what the possible consequences of particular knapping operations are. The point is that these pre-understandings guide the entire process of reasoning and potentially inform each interpretive claim. 'Synthetic' approaches are much more susceptible and open to individual lithic expertise than their 'analytic' counterparts.[280] In the Anglophone case scholarly expertise of course also plays a role, but it is typically important in the context of mastering particular analytic tools (i.e., various computer programmes), specific methodologies (i.e., statistical procedures and tests), and in the construction of testable hypotheses from well-selected bodies of general theory.

The Anglophone position reflects the proclivity to safeguard the subject-neutrality of lithic analysis and interpretation. The human subject is typically regarded as a knowledge-distorting factor, only accentuating the problem of lithic knowledge by adding another layer of artificial interpretive variability. The standardisation and 'automatisation' of inferential procedures and argumentative figures has consequently to be understood as an attempt to render lithic knowledge claims as *independent* as possible from individual and at best variable scholarly judgements. The Anglophone stance towards the treatment of lithic evidence can thus be characterised as broadly 'etic.' French technological research, by contrast, is often regarded to provide a level of understanding that can be qualified as 'emic' in the broadest sense (cf. esp. Pigeot 2005).[281] An important consequence of this configuration is that Anglophone scholarship widely promotes computer-aided applications and robotic facilities in order to study lithic technology in maximally 'human-devoid' fashion (cf. e.g., Clarke 1968: Chapter 13; Dibble and McPherron 1988; McPherron and Dibble 2002; Dibble and Rezek 2009; Brantingham 2010),[282] whereas the French research tradition encourages its representatives to cultivate their personal qualities of inquiry, for instance object-matter experience as well as argumentative and interpretive skill (see *supra*).[283] That these differences help to make sense of the French-Anglophone divide at least supports the idea that the conflict between the two parties is related to basic difficulties of navigating the 'analytic'-'synthetic' boundary.

3.2.3 ***Role of theory and data***

If there is anything we can learn from Pepper's enunciations of Western thought, it is probably that 'theory' can come in many guises. Just as there is conflict among world hypotheses about what can legitimately identified as 'pure' fact or even 'data' (cf. Pepper 1942: 51-59, 63-70), theoretical enterprises may vary vastly between them. Theoretical work in science does at least not only concern 'grand-theories,' grounded in more or less well-founded regularities, but theory, for instance, plays an equally important role in the miniscule comprehension of historical events – although the latter is

[279] Personal and qualitative lithic experimentation is a core practice in the French tradition and there is a huge body of literature that reflects this condition (cf. e.g., Tixier 1978 [2012]; Roche and Tixier 1982; Binder and Pelegrin 1983; Boëda and Pelegrin 1983).We will see in Chapter 5 that one can add a certain subject-based quality of being 'skillful' in *reading* lithic artefact and assemblages (frz. *lecture*); typically, this entails experience and proficiency in practices of physical and 'mental refitting'. General dimensions of experience with the source material, for instance knowledge about similar and different assemblages, are similarly important.

[280] Cf. **Appendix III.2: Fig. III.4: A**.

[281] For the distinction between 'etic' and 'emic,' see esp. Harris (1968: 571f., 575-578). For an explicit critique on 'emic' tendencies in French Palaeolithic archaeology, see for example Boissinot (2011: 299-301) and Tostevin (2011b: 354f.).

[282] See also Binford and Binford (1968) and the well-developed branch of Anglophone simulation-driven research (e.g., Grove 2008; Barton and Riel-Salvatore 2014; Premo and Tostevin 2016). It is notable, and appears not at all to be coincidental, that such simulation-driven research is virtually absent in the French scene, it is even unclear how such inquiry would contribute to the current lithic discourse(s) there.

[283] A telling example of the central role of first-hand experience in French lithic analysis is Boëda's recent book *Techno-logique & Technologie. Une Paléohistoire des objets lithiques tranchants* (2013), in which the author seems to deliberately rely only on those lithic assemblages which he himself has studied and/or at least examined in some detail to construct his arguments and develop his general narrative.

often discredited as 'atheoretical.' Theories cannot only be found in "explicit explanatory systems of propositions but also in analytical, interpretive, methodological, and argumentative choices" (Abend 2006: 6). The question is therefore not whether theoretical activity is an essential part of lithic research, but rather what the status and role of theory in different epistemological endeavours is. Pepper's expositions call our attention to the basic fact that all facets of research, including the most primitive categories such as 'theory' and 'data,' are subjected to world-theory interpretation. The point is that these epistemological footholds are variables in themselves, their character depending on the type of world hypothesis that motivates them. This section asks whether French and Anglophone theory-use in lithic research actually differs, and whether the kinds of theories brought to bear relate dissimilarly to the available evidence and to other pieces of theory. If there is a general difference, it should reflect some of the pertinent features of the 'analytic'-'synthetic' divide among world theories.

In the Anglophone lithic discourse, 'theory' plays an extremely important role. Theory-building is an explicit, independent, and well-delineated area of scholarly activity (cf. e.g., Binford 1964, 1977; Binford and Binford 1968; Clark 2002).[284] Theory seems to serve two primary purposes: first, it organises and systematises the general repertoire of ideas and understandings about the world in order to facilitate the extraction of *testable* and *highly specific propositions* (i.e., hypotheses); second, theory is an important tool of *explanation* and it is hoped that empirical findings can be illuminated by linking them effectively to theoretical insights. The two are obviously complementary. The general lesson, consistent with the previous section, is that practices of 'theorisation' are *exogenous* to practices of empirical data-analysis; they are the logical entry point of an investigation and motivate the formulation of particular research questions as well as the collection of specific kinds of data. Data without theory are typically seen as rather 'hollow' and 'meaningless.' Some authors would certainly go as far as to argue that data cannot even exist without a theoretical underpinning (e.g., Clark 2001: 139). This epistemological primacy of theory-making and the dependence of data on theory is a classical tenet of 'analytic' modes of investigation. 'Analytic' research thereby acknowledges the 'theory-laden' nature of most of the available data.

Because 'theory' is at the centre stage of the Anglophone research enterprise, scholars have developed a rich and diversified taxonomy of theories, acknowledging that different types of theory have a different function in the research process. 'General' theory, for instance, specifies general principles of nature, general relationships between two or more variables, or law-like behavioural dispositions which may have led to the observable patterns in the archaeological record. 'High-level' theory is sometimes also used to designate this species of theory. 'Low-level' theories, by contrast, have a different role in the reasoning process. Rather than guiding the explanatory endeavour, they tend to provide the needed clues of how to prepare and connect disparate pieces of evidence in order to render them interpretable. The most attention, however, is typically paid to 'middle-level' theories since they are thought to connect the strictly observational realm with the domain of potentially explanatory 'high-level' or 'general' theories.[285] The striking impact of Binford's (1977, 1978, 2001) 'Middle-Range-Theory' (MRT)[286] programme on the development of Anglophone research in Palaeolithic archaeology provides a telling example of this general logic of theory-use.[287] The key task of 'theories of a middle range' is to provide *independent* guidelines – e.g., the specification of relevant observable variables and their interrelationships – on how one can reach out from a 'static' record to a 'dynamic' past (cf. Shott 1998). The important point is that the call for MRT spawned a *separate branch of research*, highlighting the central role of theory-building in shaping the entirety of the Anglophone research architecture:[288]

[284] See esp. Tostevin (2012: 27-41) for a useful summary of important axes of lithic theorisation in current American archaeology.
[285] See Bernbeck (1997: 65-84) for a useful summary.
[286] The basic concept of MRT, although never acknowledge by Binford (1983a: 19, Note 5), is borrowed from sociologist Robert Merton (1949). See Raab and Goodyear (1984) and Shott (1998).
[287] Schiffer's (1972, 1976, 1983) 'behavioural formation theory' falls of course into the same category.
[288] This is the birthplace of Anglophone 'ethnoarchaeology' as a *frame of reference* for archaeological reasoning (Yellen 1977; Binford 1978; McCall 2012; cf. Trigger 2007: 399). It is important to recognise that this specific understanding of 'ethnoarchaeology' is strictly opposed to the French idea of 'prehistoric ethnography' (*Ethnologie préhistoire* or *Palethnologie*), which seeks to maintain a high degree of interpretative intimacy with the archaeological facts and focuses on the description of 'quotidian' particularities (e.g., Leroi-Gourhan 1971; Leroi-Gourhan and Brézillon 1972). For a more recent sceptical voice against ethnoarchaeological theory-building and 'analogising,' see Perlès and Vanhaeren (2012).

> "The conclusion should be clear: Middle-range research, with particular emphasis of theory building, is crucial to the further development of archaeology. We cannot "know" the past without it, and we cannot evaluate our ideas about the past and why it was the way it appears to have been without means of monitoring the conditions or variables believed to be important. Both of these tasks are dependent upon the development of middle-range research." (Binford 1981b: 30)

This highly differentiated theory-scape and the critical role of MRT-research therein further underlines that the structural principles of knowledge corroboration are clearly 'analytic.' With Pepper (see Chapter 2), we can say that the respective theories of truth mobilised to evaluate and criticise reasoning are based on 'correspondence' or 'causal-logical necessity.'[289] Again, the goal is to compare the 'observational' with the 'theoretical,' and to climb up various levels of theory if needed. This comparison between 'data' and 'theory' proceeds either in terms of *analogy* or *similarity*. Clarke (1972a: 643), for instance, tried to capture this basic strategy by noting that "[h]ypotheses are developed to relate observed properties to one another by means of a structural concept." It is equally reflected in Binford's (2015 [1972]: 110f.) insistence on the importance of first 'describing similarities and differences' in archaeological parts and then 'explaining them by means of theory-informed hypotheses.' The categorical distinction between 'theory,' 'hypothesis,' and 'data,' characteristic of science in the 'analytic' mode (see the previous Section), is therefore clearly a hallmark of Anglophone approaches.

The result of this research logic is a layered framework of inquiry, describable in terms of a 'superstructure-substructure' configuration. Dennell's (1983) juxtaposition of the traditional Continental European research configuration, which he describes as essentially 'culture-historic' and non-layered, with the "new" layered architecture of research he and his Anglophone colleagues are working with exemplifies this condition (**Fig. 5**). Only the latter supports well-defined levels or scales of inquiry and the discrimination between 'general' and more 'specialised' bodies of theory. It should be recalled here that much of the 'anthropological' re-orientation that Anglophone Palaeolithic research experienced from the 1960s on was motivated by the tantalising prospects of bringing to bear general theory and to learn more about the invariables of past human behaviour (e.g., Binford 1962, 1965; Yellen 1977). This ties in with conceptualising 'knowledge,' 'findings,' or 'facts' in layers (e.g., Potts 1988: 297-300) and representing the process of knowledge production as a 'ladder of inference' (Hawkes 1954) with different aspects of past behaviour being differentially challenging to reconstruct (cf. Clark 1952, 1989; Clarke 1968: Fig. 49).[290] Together with the mobilisation of well-delineated levels of theory (cf. Schiffer 1988; Tostevin 2011b: 353f.), all of this reflects a conception of worldly-order emphasising *verticality* and *hierarchy*. This, in turn, nicely captures the already outlined epistemological trade-off between data-conception and world-conception which characterises Anglophone inquiry.[291]

The recurrent call for 'model-building' that prevails in Anglophone research circles (e.g., Clarke 1972a, 1977; Hammond et al. 1979; Lycett and Chauhan 2010b: 8-12) is a comparable attempt to close the gap between the theoretical and observational dimensions of research. Models can be understood as conceptual devices that break down a piece of theory into its most basic elements and operationalise it with regards to specific test-conditions and the kind of evidence the case provides. By "making a series of simplifying – but precise and explicit – assumptions, such that parameter values taken from empirical data can be compared for goodness-of-fit against those precisely laid out assumptions" (Lycett and Chauhan 2010b: 10), models help relating theories to data. Alternatively, models may assist in theory-building since they enable the *direct* assessment of particular theoretical assumptions or sets of assumptions in terms of their archaeological consequences. Model-building is then an independent operation that can inform theory-building. In any case, the very notion of a *mod-*

[289] Cf. e.g. "Clearly if we can isolate causal relationships between things, and if we can understand such relationships in terms of more general principles of necessity, such as the theories of mechanics or some other basic science, then we have a strong warrant for the inference of the cause from the observed effects. We would be building a strong theoretically informed bridge between properties of the contemporary archaeological record and characteristics of the dynamic past" (Binford 1981b: 26).
[290] There are two dimensions to this: first, the old Baconian idea of the 'pyramid of knowledge' and 'levels of intellect' provides the prototypical example of the 'formistic' conception that knowledge about the world is typically gained in different *qualities* – that there is a *ladder of knowledge* (see Chapter 2); second, 'mechanism' introduces layers of 'facts' or 'insights' in order to account for the *differential relevance* of information for answering particular research questions (*idem*). Because such questions are specified with the help of orientating theories, the world is rendered a hierarchical place with different layers of information only being significant for solving certain problems.
[291] See again **Tab. 3**.

el is already 'analytic' since a model's purpose is always to evaluate whether or not particular combinations of parts given particular conditions could have produced the sought-for whole(s).[292] The use of computer-based 'simulations' serves a similar purpose. Quite often, *simulation* is simply a method to explore the properties of a model when traditional analytic methods are not available or if one wants to explore more complex problems that require the modulation of multiple parameters (cf. Grüne-Yanoff and Weirich 2010: 21-26). The implementation of both formal-mathematical models and computer-driven simulations is therefore a testimony of 'analytic' thought (Aldenderfer 1981, 1991). The fact that both play an important role in current Palaeolithic research in the Anglophone world,[293] but are virtually lacking within mainstream Palaeolithic archaeology in France suggests that the 'analytic'-'synthetic' separation is of some significance here:[294]

> "What is a model? Models are pieces of machinery that relate observations to theoretical ideas, they may be used for many different purposes and they vary widely in the form of machinery they employ, the class of observations they focus upon and the manner in which they relate the observations to the theory or hypothesis. It is therefore more appropriate to describe models than to attempt a hopelessly broad or a pointlessly narrow definition for them. Models are often partial representations, which simplify the complex observations by the selective elimination of detail incidental to the purpose of the model. The model may thus isolate the essential factors and interrelationships which together largely account for the variability of interest in the observations; in this way the model may even share a similarity in formal structure with the observations." (Clarke 1972b: 1)

This important role of 'theory' in Anglophone research makes it in principle possible that scholars can concentrate almost exclusively on theoretical inquiry and try to advance the theoretical discourse rather than doing a lot of fieldwork or primary data-analysis – periodicals such as the *Journal of Archaeological Method and Theory* testify to this situation.[295] The same research configuration also explains why secondary data – that is, data collected from the literature – may be as important as primary data and continues to delineate a lively field of scholarly activity and debate.[296] Because theoretical matters are negotiated *explicitly* and are widely recognised as crucial for the development of the field, practitioners tend to specialise relative to taken-for-granted 'theory'-'data' dichotomies and to devise expert areas of inquiry mirroring these dichotomies. Overviews of Anglophone, especially U.S. American Palaeolithic archaeology are therefore often organised according to theoretical orientations (cf. Clark 2008: 54-59). Ecological theorists (e.g., Butzer 1982; Kelly 1988; Torrence 1989c; Kuhn 1995; Shea 2011b, 2017a) are for example contrasted with reduction theorists (e.g., Dibble 1987, 1995b; Henry 1989b; McPherron 1994; Iovita 2008; Olszewski 2016), cognitive theorists (e.g., Gowlett 1984; Mithen 1996; Stout 2011; Wynn and Coolidge 2016), design theorists (Bleed 1986; Bousman 1993; Bamforth and Bleed 1997), style theorists (e.g., Sackett 1973; Wobst 1977), formation theorists (e.g., Isaac 1967; Binford 1979; Toth 1985; Bunn and Kroll 1986; Stern 1993, 2008), or scholars working within the confines of Neo-Darwinian evolutionary theory (e.g., Dunnell 1989; Lyman and O'Brien 2000; Shennan 2002; Kuhn 2004a) – to name but a few of the relevant theoretical orientations propelling Anglophone lithic inquiry. The diversification of approaches relative to 'high-level' theories is sometimes described with the concept of 'paradigms' (e.g., Clarke 1972b: 1.1, 1.16).[297] A paradigm in this sense defines a general theoretical inclination, pre-organising the rich theory-scape in order to narrow down the range of operational theories that may be selected in the context of a particular re-

---

[292] Model-use is also 'analytic' in terms of its truth-conditions. Clarke himself (1972b: 1) notes that "[t]he relation between the model and the observations modelled may in general be said to be one of analogy, or in the case of logical and mathematical models more usually one of isomorphism […]." Again, some to be specified *analogy* or *similarity* relationships (isomorphism is a special case of similarity) are exploited to corroborate knowledge claims that derive from model-based approaches. See Chapter 2 for an exposition of the 'formistic' and 'mechanistic' theories of cognitive criticism underlying this mode of corroboration.
[293] Recent examples of simulation-based research in the Anglophone world are Mithen (1990), Steele (1994), Shennan (2001), Powell et al. (2009), Romanowska (2015), and Barton and Riel-Salvatore (2016).
[294] Compare, for example, the mentioned simulation-authors in Lake (2014) for a rough indication.
[295] The work of Clive Gamble (1986, 1998, 1999, 2007) exemplifies a broadly theory-oriented career. Gamble's theoretical contributions have framed many discussions in the field and sparked often-controversial debates. Although his views were regularly met with criticism and scepticism, they certainly shaped the Anglophone discourse – if only as a *contrastive foil*. The more recent cooperation between Clive Gamble, John Gowlett, and evolutionary psychologist Robin Dunbar has resulted in the integration of some of the most important strands of British Palaeolithic archaeology under the umbrella of the 'social brain theory' (cf. Gamble et al. 2011, 2014; Gowlett et al. 2012).
[296] The re-assessment of the classic question of interassemblage variability in the Western European Mousterian by Szmidt (2003) offers a prototypical example of the productive usage of secondary data in Anglophone lithic research.
[297] See also Isaac (1972b: 193, Note 1).

search problem. A research 'paradigm' sits at the summit of the epistemological pyra -mid, reinforcing the layered character of theorisation in wider Anglophone research.[298]

This overwhelmingly 'analytic' signature of theory-mobilisation is met by a much more ambivalent use of 'theory' in the French research context. It has to be said from the start, however, that theoretical considerations *have* always played a role in directing French inquiry – even within Bordian 'straight archaeology' (*sensu* Sackett 1991). In the context of lithic analysis, this is for example well-illustrated by Geneste's (2010 [1991]: 420-429) extensive discussion of the various theoretical currents and thinkers that have contributed to the conceptual orientation of the *chaîne opératoire* approach. He mentions primarily the 'History and Anthropology of Techniques' including what in France is called *« Technologie culturelle »*, philosophy of technology, cybernetics, and general systems theory.[299] Similar theoretical discussions can for instance be found in Bon (2009: Chapitre IV, 223-240), who draws on ethnology and sociology, and Valentin (2008a: Chapitre 1), who examines in detail the relationship between history and prehistory and tries to reinvigorate Furet's (1975) vision of 'problem-history.' Yet, the way in which theory is debated and made use of in these works clearly suggests that 'theorisation' is not regarded as an analytical operation in the narrow sense of the word. Theoretical considerations mostly remain in the 'background' and are rarely formalised or made overly explicit in terms of their consequences.[300] This utilisation of theory as 'background theory' serves to guide and orientate analysis, contextualisation, and interpretation – it is neither explicitly tied to the logic of discovery, nor is theory regarded to have a distinct explanatory value. Moreover, theory is typically 'historicised' in France and considered to be intimately bound to the evolved disciplinary fabric of Palaeolithic archaeology (e.g., Audouze et al. 2018).[301] Theory is therefore to a much lesser degree negotiable independently of broader intellectual developments.[302]

In her recent review of the French technological approach, Perlès (2016: 231f.) also stressed that theories are usually mobilised *implicitly* by practitioners and that the latter typically feel no need of 'labelling their approach, theory, or method.' The first aspect is illustrated by the case of Leroi-Gourhan – the *« Patron »* of the Parisian research trajectory – whose major works *Évolution et techniques* (1943/1945) and *Le geste et la parole* (1964/1965) are characterised by a practice of implicit reference-making (e.g., Martinelli 1988; Sigaut 2010; Delage 2017: 164). This practice, putting forth a radical form of 'intertextuality' (*sensu* Genette 1982), deals with a broad range of theoretical sources, often in somewhat idiosyncratic ways, without citing or mentioning the respective authors or primary works.[303] Audouze (2002: 292), for instance, notes that Leroi-Gourhan's thought was "like an octopus, sending tentacles in many directions, but all ultimately connected." The point is that theorisation is often considered a rather 'mundane' and perhaps even 'un-exciting' undertaking, which naturally takes opportunity of its wider intellectual context without elaborating too much on this context. Influential theoretical perspectives do not need to be named or addressed specifically since they belong to everybody's broader 'horizon of knowing.' Explicitly dealing with them would un-necessarily complicate the train of thought, often hindering the readability of scholarly productions. This becomes especially apparent in the *œuvre* of the 'Early' Leroi-Gourhan, which is rather complicated in its conceptual structure and benefits from many different, but often *prima facie* non-connected ideas.

Another reason for this rather 'intangible' mode of theorisation is that theory is developed 'on the way,' that is, in the process of dealing with a particular problem, rather than beforehand (cf. Audouze 1999). Theories are regarded to be useful only if they help to illuminate particular problem-

[298] An interesting consequence of this research configuration is that intergenerational theory change is often modelled in terms of a Kuhnian *change of paradigms*, the implication being that disciplinary advancement suddenly depends on theoretical novelty and the ability of a new generation of scholars to contribute something substantial to the theoretical discourse.
[299] For similar points, see e.g. Julien (1992), Schlanger (2004), Perlès (1991a, 2016), and Audouze et al. (2018).
[300] See Cleuziou et al. (1991) for an illuminating discussion of the apparent 'atheoreticality' of French prehistoric archaeology.
[301] See Olivier (1999: 99) for a similar argument which, however, differs in its details from the perspective outlined here.
[302] It may be possible to argue here that 'theory-building' is therefore less of an individual task but concerns the research community as a whole. Accordingly, the guiding, one could say 'founding,' theories of the discipline are incrementally built up by multiple generations. If this reading is appropriate, it would show that even theory-building follows a 'synthetic' logic in France and really concerns the whole of the research process rather than its effective parts (i.e., individual scholars).
[303] This mode of referring to the wider intellectual sphere is typically intertwined with a particular *mode of scholarly self-enactment*. Tendencies of 'intertextuality' seem to be particularly strong if 'erudition' is considered a cognitive virtue and when scholars identify themselves as *intellectuals*. Arguably, intellectuality is of a much lesser importance in the Anglophone research enterprise, which tends to emphasise the 'scientific' qualities of researchers rather than their intellectualism.

contexts – the concept of a 'general theory' has little meaning here.[304] This suggests that 'theory,' for the most part, cannot stand for itself. It is useful not because of its essential content, but because of its possible relationships to other theories and the interpretive perspective it provides on particular sets of evidence.[305] Theory, therefore, is in principle not treated differently than data.

The second aspect – the question of 'naming practices' – is linked to the logic of specialisation and disciplinary persuasion in France. Practitioners indeed do not seem to identify themselves and what they do in terms of 'theory-related' labels. They, for instance, define their place in the research community by referring to long-standing or developing umbrella approaches specifying certain 'agendas,' 'visions,' or 'ambitions' of research (cf. Ramírez Galicia 2016). Examples are *« Ethnologie préhistoire»* or *« Palethnologie »*, *« Technologie préhistoire »*, and *« Paléohistoire »*. The important point is that these approaches are defined by a certain theoretical matrix and adopting them implies also to adopt the corresponding theoretical orientation. Because these umbrella approaches are essentially historical entities, the theoretical matrix that comes with them is a product of particular *disciplinary traditions*. This again suggests that the French conception of 'theory-making' is grounded in the idea that ongoing research and theoretical inquiry inseparably go together, i.e., co-enable each other. Theorisation is therefore certainly not regarded to be primary, nor to be a distinct arena of scholarly engagement. Moreover, rather than specialising relative to theoretical positions, lithic practitioners usually specialise relative to well-attested differences in the stone artefact record: researchers usually consider themselves experts in Magdalenian, Solutrean, Aurignacian, Mousterian, or Acheulean lithic technology; they may equally specialise into broader periods such as the Lower, Middle, or Upper Palaeolithic and in particular kinds of technology (i.e., *façonnage*, *débitage*). This again signals that matters of theorisation are subordinate to perceived differences in the object-matter at hand.

A particular detail of implicit theory-mobilisation may be of importance here. As for example illustrated by Valentin's (2011: 56-59) short discussion of concepts of 'culture,' 'tradition,' and 'currents of culture' (*courants culturels*), individual terms such as 'gesture,' 'technique,' 'habitus,' and 'social morphology' actually stand for larger theoretical discourses in which they continue to have a specific meaning.[306] They are, in other words, *pars pro toto* and reflect more general theoretical insights. This is quite critical because it demonstrates the 'synthetic' take on theory that prevails in the French tradition. It also confirms Coudart's (1999) suspicion that instead of speaking of 'theory-building,' we should probably talk about *conceptual work* in the French context. This *prima facie* somewhat subtle difference in fact explains what theoretical activity in French lithic research amounts to. Above all, theorisation refers to the development and refinement of *interpretive concepts* that help interrogating the primary lithic evidence.[307] The classic contributions which continue to define the theoretical foundations of lithic inquiry such as Inizan (1976), Perlès (1980), Pigeot (1983), and Pelegrin (1995) coined at least one important research concept. Conceptualisation is also the key operation when scholars develop new ways of describing and interpreting the modalities of core management (e.g., Ploux 1988; Valentin 1995: Annexes). A more recent example of a similar practice is the conceptual distinction between 'integrative' and 'additive' structures of core exploitation (Boëda 2013: 89-102).[308] All of this clearly indicates that the construction and implementation of interpretive concepts geared towards the specific problems of lithic analysis proves to be one of the most potent loci of theoretical innovation in current French lithic research. Theorisation is considered a conceptual business *embedded* in data-analysis. It supports meticulous and highly-differentiated terminological systems in order to facilitate empirical research. Theoretical work therefore always resonates with the 'whole of the research process, it does not contain or define that whole.'

We can conclude from this that 'theory' is really handled 'synthetically' in French technological research. The various practices of bringing it to bear generally question whether any meaningful dis-

---

304 Note that the rejection of 'general theorising' is also the consequence of an initial research focus on 'how-questions' rather than why- or what-questions (e.g., Tixier 2012 [1978]).

305 Cf. "As Guille-Escuret recalls, Leroi-Gourhan was such a prodigious professor because, in his approach, observation and theory were associated in an insoluble whole. Each served to correct and consolidate the other as the work progressed (Guille-Escuret, 1994, p. 10)." (Audouze 2002: 298)

306 The term *chaîne opératoire* is no exception here.

307 To be more specific: most of the time, these interpretive concepts help to delineate and characterise 'sub-wholes' in the investigated lithic assemblages (see *infra* and Chapter 5 for a more detailed discussion).

308 A complementary but not entirely alternative distinction is between the 'partial' and 'total configuration' of a core matrix (e.g., Carmignani et al. 2017: Fig. 16). For a detailed discussion of these concepts within the context of the 'techno-genetic' approach, see the second part of Chapter 5.

tinction between 'theory' and 'data' can realistically be made. Rather than embracing theory as a distinct field of inquiry, French scholars tend to engage in conceptual activity to alter their 'exposure' to the lithic evidence. This already implies a somewhat dialectic relationship between the 'theoretical' and 'observational' aspects of research. At the same time, the link between more general pieces of theory and explanations of the evidence is much 'looser.'[309] This is because the primary role of theory is to put lithic observations *into perspective* and because scholars typically agree that no simple or one-to-one relationship between theory and data exists. Neither theory nor data can therefore legislate over each other. Theory therefore typically serves an interpretive 'crutch' and becomes just another vehicle of argumentation and, potentially, narrative enrichment.[310] Because theory seems to be subjugated to *interpretive ends* rather than the other way around, theoretical considerations are typically 'weaker' than in most Anglophone research contexts. Yet, they are often much 'thicker.' This is because theory rarely comes in the singular and there is little concern for theoretical purity. This adds to the already raised issue of implicit theory-use in the French scene.

On a general level, one can therefore agree with Tostevin (2011b), who has recently noted:

> "One reason for the absence of a discussion of the theoretical differences between the [French and Anglophone] approaches in the present debate is the fact that the explicit espousal of high-level theory is considerably different in each context (Bleed 2001). Archaeological theory is not conceived of exactly the same way by proponents of the two approaches. This frequently results in explicit statements of theoretical orientation by American reduction sequence proponents and implicit orientations within methodological discussions by *chaîne opératoire* proponents." (*ibid.*: 353; original emphasis)

The comparative examination of French and Anglophone theory-use indeed shows that 'theory' serves a vastly different purpose in both research contexts. Not only are the 'theoretical' and 'empirical' domains of research unequally articulated in both cases, the way how theory is understood and conceptualised fundamentally differs. This divergence reproduces Pepper's epistemological division between 'analytic' and 'synthetic' modes of thought. The crucial point, therefore, is not only that French and Anglophone practitioners typically call upon dissimilar bodies of theory, but that they would mobilise even the same body in different ways.[311] An 'analytic' understanding of theory, characteristic of Anglophone lithic research, emphasises the role of theory as a well-defined part of the research process and calls for a precise formal analysis of theories themselves, whereas a 'synthetic' grasp of theory, found in large parts of the French scene, leads to the recognition that theory is always transgressive and has to be developed in close dialogue with specific sets of evidence. The 'synthetic' view rejects the idea that practices of theorisation can be separated from the overarching logic and trajectory of specific lithic inquiries. All of this strongly indicates that French and Anglophone lithic approaches are fuelled by different kinds of world hypotheses and that the 'analytic'-'synthetic' distinction plays an organisational role in this.

3.2.4 *Styles of visualisation*

Chapter 2 has taught us that empirical research can profit tremendously from visualisation and that different strategies of 'making visible' are likely to be deployed by varying research programmes. Generally speaking, pictures and images are non-textual elements of inquiry that not merely 'result' from the interrogation of evidence, but can *actively* contribute to the process of reasoning and knowledge formation (cf. e.g., Lynch and Woolgar 1990; Rheinberger 1992; Topper 1996; Bredekamp et al. 2008).[312] Tactics and strategies of scientific visualisation aid scholars in handling the available data –

[309] Leroi-Gourhan's general scepticism towards the direct use of analogies – anthropological or otherwise – illustrates this point (cf. Valentin 2015: 176). Taking up this point, Cleuziou et al. (1991) contend that "[t]he major weakness of French archaeology in this respect is that the scepticism expressed – by Leroi-Gourhan, for example – concerning the construction of cultural models or the notion of culture itself, leads to the use of notions which are even more dangerous because they are implicit."
[310] An example of this 'argumentative function' of theory is provided by Renard and Ducasse (2015). Their approach to mobility and techno-economy is discussed in detail in the first part of Chapter 5.
[311] The recognition that different standards of theory underpin French and Anglophone Palaeolithic archaeology also defuses the allegation of 'atheoreticality' which has regularly been brought forward by a number of U.S. American practitioners (e.g., Binford and Sabloff 1982; Straus 1987, 1991; Clark and Lindly 1991; Clark 1993, 2001; Conard 2009; cf. Wargo 2009: 110, 114-119).
[312] For a general discussion of the increasingly evident 'more-than-representational' status of scientific imagery, see Daston (2014).

they can guide interpretations, mediate cognitive operations such as 'analogy-building' or 'metaphor-exploration,' and provide independent arguments for or against whatever claim one wishes to defend. Rendering research problems or specific data-configurations 'visible' is therefore often equally important as, say, conducting a statistical test (e.g., Latour 1986; Daston 2008; Suchman 2014). After all, many of the research operations that are now commonly used in Palaeolithic archaeology have a visual component and the *manipulation of visual evidence* becomes an increasingly important domain of scholarly activity (e.g., Magnani 2014).[313] Some scientific publishers, for example, have already begun to promote the employment of 'graphical abstracts.'[314] Any analysis of scientific practice should therefore not only focus on the latter's structural and 'written' aspects, but also take into consideration the unique 'rhetoric of images':

> "After some twenty years of remarkable work on visualization in science, it is now astonishing to recall how blind historians of science once were to anything but words: scientific texts were purely textual; when we came to an image (a drawing, a graph, a table, a diagram, a photograph, it was all one), we just flipped the page. Illustrations in history of science monographs, insofar as there were any, consisted almost exclusively of portraits of past scientific luminaries. Pick up almost any recent book or article in the field now and it is likely to be peppered with images, many of which are as essential as the well-chosen quotation is to making the author's point. Images have come into their own as a source for the history of science, even if we are still learning how to interpret them and to emancipate ourselves from text-centered analogies such as 'reading images' and 'visual literacy'." (Daston 2014: 319)

Images are important footholds of reasoning because they are considered to enable an 'immediate' access to the phenomena under consideration, as well as to enshrine a 'tangible objectivity' of knowing that words can never hope to match (cf. Daston and Galison 1992). Visualisations may indeed say 'more than thousand words' and often appear to satisfy, by means of their clarity and visualisability [*Anschaulichkeit*] enhancing capacities,[315] the old ideal of 'direct scientific observation' (Daston 2008). Because of these qualities, scientific imagery can provide a shortcut to the key message of the scholarly production(s) in question and greatly facilitates the identification of peers and other like-minded practitioners. To put it simple: similar 'image worlds' typically indicate that scholars work on broadly similar problems, utilise similar methods, and share some basic or at least cognate assumptions (cf. Lynch and Woolgar 1988; Bueno 2012, 2016).[316] This last point is of particular importance in an age in which scientific knowledge seems to be disseminated at ever-accelerating speeds and the full range of scholarly outputs has become almost unmonitorable. All of these aspects can be exploited in order to analyse the specific role of images in a given research context. Are particular approaches distinguished by particular types of images? Do different research communities cultivate disparate sets of images or incompatible modes of image-use? And if so, can these help us in understanding the logic of research regulating the interpretation of evidence in these contexts?

This section will explore the 'visual signature' of French and Anglophone lithic approaches. The investigation thereby mainly focuses on the assemblage-based case studies introduced in Chapter 1, yet also takes into account some more general features of lithic visuality in both research spheres. The central question is whether there is a substantial difference in the logic of image-use when French and Anglophone lithic approaches are compared, and if so, whether this difference can be accounted for by the conflict between 'analytic' and 'synthetic' world hypotheses. Lithic practice appears to be particularly well-suited to answer these questions since there is a long-standing tradition of drawing and photographing stone artefacts or organising them in diagrams (e.g., Dauvois 1976; Laurent 1985; Addington 1986; Martingell and Saville 1988; Adkins and Adkins 1989). The importance of visualising both objects and data in lithic research is only increasing as we speak and recent years have witnessed a vast surge of new technologies for processing, manipulating, and representing various kinds of visual information. Shott (2014), for instance, even argues that the field is currently undergoing a true 'visual revolution.' A Pepperian perspective should help us to better understand the general role of these im-

[313] For discussions of the role of visualisation in wider archaeology, see Shelley (1996) and Kavanagh (2007).
[314] See for example the special entry on 'graphical abstracts' on the Elsevier webpage: "A Graphical Abstract is a single, concise, pictorial and visual summary of the main findings of the article. This could either be the concluding figure from the article or a figure that is specially designed for the purpose, which captures the content of the article for readers at a single glance." (web-text accessed on the 7th of July 2018)
[315] Cf. e.g., de Regt (2014: 378).
[316] It may therefore be argued that scientific imagery, in a perhaps unique manner, makes *explicit* what otherwise remains sedimented in the opacity of textual discourse.

ages in lithic knowledge production.[317] Moreover, the results can be expected to complement the previous findings of this chapter and, if necessary, serve as a corrective measure.

With Lopes (2009: 6), we can distinguish between three axes of pictorial practice, along which lithic imagery is expected to vary. The first is the deployed *image-type*, with drawings, schematisations, pictorial diagrams, photographs, tables, or graphs being examples of different kinds of lithic images.[318] The second is the *imaging task*, which is the purpose of the image broadly conceived – the question here is for instance whether the image is used to illustrate an argument, present data, perform an inference, specify hypotheses, or conduct some sort of proof. The third axe is the *image context* or 'context of use.' This dimension of scientific imagery is the disciplinary, topical, and/or 'working' context of individual visualisations. It is linked to broader questions about the role and function of particular media (e.g., research monographs, field reports, specialised journals) as well as to the design and focus of a specific study (e.g., highly focussed, comparative, synoptic, mono-specific). The three axes of image-use are often interconnected (cf. Gooding 2004: 551-555) and to understand the respective relationships can be imperative in order to expound different modes of visualisation. Methodologically, keeping constant the 'image context' enables a more effective comparison of visualisation practices between distinct research communities, even though it has to be said that both research design and focus of inquiry are often variables in themselves when such research communities are contrasted (see previous Section). It is therefore usually unpractical to fixate the 'image context.' A more promising strategy, especially for the present purpose, is to compare the overall character of image-use, which is simply a function of all three aspects of visualisation. By examining the spectrum of 'image-types' and 'imaging tasks' in a given 'image context,' it should be possible to extract the general *logic* of employing lithic imagery. It is this logic that can then be compared.

Because images, as argued before, can to a certain extent 'speak for themselves,' it is also possible to investigate what an image silently *presumes* about its object matter. This opens up some important angles of interrogation. How do lithic images conceive of part-whole relations in whatever they visualise? Do they primarily show parts or wholes? What are the relevant parts and the effective wholes in the images, if any? And what can this tell us about what is considered to be lithic data in the first place? All of these questions resonate with basic features of Pepper's epistemology and examining them should therefore help us assessing whether image-use at the French-Anglophone interface reproduces 'analytic'-'synthetic' antagonisms. Drawing on Pepper, we can even ask more specific questions, for example whether the 'imaging task' is completed by putting the spotlight on 'particulars,' 'characters,' 'classes,' 'types,' 'relations,' 'qualities,' 'fragments,' or 'nexuses.'[319] Since these categories have specific world theory implications, we can gain some additional and potentially complementary insights about the French-Anglophone divide. I will begin with a quantitative examination of the lithic imagery employed in the three pairs of assemblage-based case studies.[320]

Table 4 captures the generalised 'visual signature' of the lithic approaches in the three paired case studies. The first striking difference is that French scholars seem to pay much more attention to representing lithic artefacts themselves than their Anglophone colleagues and tend to mobilise a variety of abstract pictorial schemas or interpretive diagrams. The latter type of imagery is completely missing in the examined Anglophone cases.[321] The Anglophone approaches, by contrast, rely more heavily on different tables and quantitative-statistical graphs. The degree of standardisation across the employed tables is fairly high. This contrasts with the relatively low level of inter-table standardisation in the French cases, where table design and table content appear to be somewhat idiosyncratic. Furthermore, the comparison of image-use reveals that in the respective French studies lithic artefact depictions always feature prominently in the principal part of data-analysis, whereas the positioning of such

[317] In particular, approaching lithic images through Pepper's lens would help in accomplishing Lopes' (2009: 5) two central tasks, to "understand imaging as a type of representation with distinctive capabilities (by contrast, in particular, with language" and to "understand the diversification of different kinds of images across different scientific contexts."
[318] One may argue that tables, some diagrams, and most graphs are not really images. Quite often, they at least do not depict lithic objects, but rather summarise aspects of data-analysis. However, the here adopted perspective on lithic visualisation is fairly pragmatic and 'inclusive' (the sum of non-textual elements in a scientific production; see *supra*), also because the analysis is guided by the informed suspicion that the importance of depicting the lithic objects themselves may vary greatly in French and Anglophone approaches.
[319] See Chapter 2 for an explanation of these structural categories.
[320] For a general description of these three cases of interpretive conflict, see Chapter 1 (esp. second part of Section 1.2).
[321] As we will see below, abstract diagrammatical reasoning is not completely absent in the Anglophone world, but tends to serve different purposes than similar image-types in French technological inquiry.

image-types, if they are present at all, is more variable in the Anglophone examples. Compelling is also the opposition between the virtual non-existence of technical symbology to supplement artefact representations in the Anglophone research context and the relatively strong reliance on similar pictorial elements in the French cases. It is certainly interesting that such a clear disparity in image-use becomes already apparent on a general level of analysis, suggesting that the logic of research producing them is indeed vastly different. But how can these differences be explained? What do they indicate and how do they interact with what we have already learned?

The differential status of artefact representations in French and Anglophone lithic research may be significant for a number of reasons. Most importantly, it suggests that the informational value of lithic *objects* is perceived unequally. The central issue is the role of objects in constructing the argument and in guiding the course of reasoning. In the Anglophone cases, images of lithic artefacts are either entirely lacking – as in the case of McPherron (1994) – or confined to the introductory section or a supplementary part (i.e., appendix, addendum, electronic supplement) – as in the case of Dibble (1995a) and Tostevin (2000, 2012). Artefact drawings, in other words, only feature 'outside' of the data-driven core sections of the analysis.[322] This, in turn, suggests that object visualisations have little to contribute to the actual processes of reasoning determining the interpretive results of the studies in question. Lithic object visualisation appear to serve an 'illustrative' rather than 'demonstrative' purpose. In Dibble's (1995a) study of the material from Biache-Saint-Vaast IIA, detailed artefact drawings help introducing the site and giving the reader a general overview of the kinds of artefacts found there. In Tostevin's (2012) study of the Kulna layer 7 assemblage, there is not a single in-text reference to the artefact illustrations provided in the appendix, indicating that they are largely dispensable for the advanced knowledge claims and are provided mainly to satisfy the curiosity of those who care what the actual artefacts look like. It is not far-fetched to attest a 'documentary' function of the respective artefact-images here – they are intended to provide a 'visual record' of the assemblage. In both cases, artefact visualisations depict 'types,' 'classes,' or 'particulars.' The fact that all of these depictions, although of course being technical drawings, emphasise the 'realism' of the lithic objects and lack additional aspects of encoded visual information, affirms the mostly *illustrational* purpose of object imagery in the Anglophone case studies (**Fig. 5**).

All of this provokes the question of 'data.' Are lithic artefacts considered lithic data at all? The visual evidence at least suggests that this question must be answered in the negative. The representation of lithic objects points to a conception of artefacts as *evidence* rather than primary data. The idea would be that lithic objects of course possess informational value – they are evidence for something – but in order to become 'data' the information they register needs to be transposed into an adequate data-format. It is only in this format that 'evidence' is turned into 'data.' With Pepper, we can understand this process as the transformation of uncriticised observation into reliable scientific 'fact.' The circumstance that lithic object representations hardly play a role in the 'context of justification' hence indicates that 'data' is typically provided in another visual format. This format is tables and quantitative-statistical graphs. We can therefore assert that the 'imaging task' of object-images is *non-analytical*. They do not specify any hypothesis, nor do they present data in the strict sense or catalyse any proof or inference. Instead, this is overtaken by the tables and graphs that showcase the lithic data, typically in numeric or digit form, and perform inferential statistics in order to provide the needed arguments, often by means of some kind of 'pattern visualisation.' The 'data' – whether provided as 'continuous' or 'discrete' variables – is always data about parts. It concerns object-particulars but also 'traits,' 'attributes,' or 'ties' (i.e., indices and other relationships between traits and attributes).[323] The general logic of image-use is therefore clearly 'analytic.' It is also evident that data-construction as reflected in imaging practices responds to requirements of *quantification*. Since the depiction of lithic objects is always ineluctably 'qualitative,' it may thus not be surprising that this 'image-type' only plays a marginal role in the examined Anglophone cases of lithic analysis.

In the French cases, the situation is somewhat different. Lithic object representations are central *argumentative devices*. Not only can they be found throughout the entire paper, some of the 'tex-

[322] See also, for example, Yellen et al. (2005: Appendix C [Figures 4-33]).

[323] Especially in Dibble's (1995a) study, lithic artefacts are grouped together in a relatively 'loose' manner. There is either no apparent selection of artefacts except for the fact that they, as *individuals*, instantiate a set of predefined and supposedly *diagnostic classes* of Mousterian artefacts, or artefact-groupings are based on broadly shared morphological characteristics or attributes (*ibid.*: Fig. 7.4-7.7). Object-images therefore clearly represent 'particulars' or 'types.'

tual' arguments are simply not comprehensible without referring to the corresponding figures. This suggests that showing objects is at least as important as talking about them. Many arguments have a textual *and* an 'object-visualisation' side to them, and both are indispensable to the construction and persuasiveness of the argument. The relationship between text and image is not only complementary and mutually reinforcing, but also of a dialectical nature. In order to retract an argument, even the reader sometimes has to move back and forth between the relevant written and pictorial parts. Both aspects of reasoning therefore seem to form an inextricable 'whole':

> "Drawings should not be considered as a prop for words and definitions, but as a genuine informative technological writing, and this is what we have attempted [...]. Far from being mere reproductions of stone artefacts, the drawings and diagrams presented here were conceived at the same time as the text and can even substitute for it, the symbols used being equivalent to a terminology. If a clear sentence is better than a vague generic term, an accurate technical drawing can usefully replace a vague description." (Inizan et al. 1999 [1995]: 17)

The important point, however, is that individual artefacts are no longer considered as evidence, but assume a status as *data*. Why is this the case? Boëda's (1988: 199-202) reconstruction of the relationship between different reduction stages and Levallois products may serve as an illustration here. The author uses schematic images to specify why and how particular core configurations and particular blank configurations inter-constraint each other (*ibid*.: Fig. 18.15-18.17; **Fig. 6**).[324] The 'imaging task' of these images is to outline and 'explore' local hypotheses and possibilities of core-blank interaction under specific technical conditions. The associated textual train of thought develops the rational arguments that link particular groups of artefacts to the outlined technical relationships. The object-images that group artefact which are interpreted to belong to the same context of lithic reduction (cf. *ibid*.: Fig. 18.18-18.20) are then presented on distinct panels in order to establish that the derived expectations are confirmed by the data. The 'imaging task' of these depictions is both 'inferential' and 'demonstrative.' The visualised lithic artefacts are data in themselves – they are shown to convince the reader that the suggested reading of the evidence *makes sense*.

A whole range of pictorial features support this view. The perhaps most significant aspect is the evident search for a 'visual match' between two or more lithic artefacts that are believed to bring forth each other, for instance specific cores and their associated blanks.[325] This 'visual match' is then further analysed in order to assess whether or not the technical and morphological characteristics of the involved lithic objects explain each other. A key point emerges from this: the corresponding logic of image-use affirms that individual artefact-features are always examined in terms of how they contribute to the 'wholeness' of the artefact insofar as this wholeness can be related to other artefact-wholes. The resulting 'synthetic' interpretation of lithic objects forbids a full reduction to 'atomistic' data-formats and partly explains why the status of numerically encoded information becomes ambivalent at best (see *infra*). Primary lithic data, in other words, must always be artefact-wholes and not their parts. Another side of this 'synthetic' orientation is the organisation of lithic objects into meaningful technical groupings. These groupings – and this iterates some of the points made in earlier sections – do not just establish (dis)similarities and correlative relationships among artefact-parts. Rather, the 'imaging task' of these object panels is to place individual artefact-wholes into larger technical wholes which, in turn, are rendered significant through their technical relations with other technical wholes. The respective imaging practice therefore typically involves considerations about *morpho-technical complementarities* and the assessment of *transitive linkages*.[326] Strictly speaking, these object-images do not represent 'particulars,' but seek to capture 'relations,' 'contexts,' 'qualities,' and 'nexuses.' The question is always how parts reach out to their significant whole(s). Parts are therefore usually *pars pro toto* and the ultimate goal of visualisation is to render the corresponding whole(s) intelligible – object-images provide *visual insight*.[327]

[324] 'Inter-constraining' here simply means that specific core configurations have particular blank consequences, and specific blank removals have particular consequences for the resulting core configuration. In order to relate cores and blanks technologically, one has to take both directions of technical amendment simultaneously into consideration.

[325] As we will see in the first part of Chapter 5, practices of *visually matching* lithic artefacts generally resonate with the idea of « *lecture* » and the 'mental refitting' approach which continue to occupy a central place in French technological research.

[326] A 'transitive' tie is an *indirect relationship* between two or more entities which entails at least one other, intermediating entity.

[327] For an important discussion of 'visual abduction' in archaeology, certainly relevant in this context, see Shelley (1996).

A general symptom of this mode of image-use is the increased selectivity of object representations and the heightened mobilisation of technical symbology. The first aspect results in the reduced realism of object-images, emphasising only technical features which are important to drive home the argument. The second aspect is reflected in the trend to enrich the provided pictorial information by introducing technical symbols to record different technical operations, or by colour-coding and pattern-coding artefact surfaces in order to indicate differential surface treatments and surface functions.[328] Both aspects are especially evident in the work of Boëda (1988: esp. Fig. 18.3-18.6) and Soriano (2000: esp. Fig. 108, 111-112, 114-115, 126-134, Annexe 2 [Fig. 138]). Practices of symbolic coding clearly exemplify a domain of lithic research in which considerable pictorial innovation has been made in recent years (cf. e.g., Inizan et al. 1995: 106-127; Nicoud 2011; Chevrier 2012: Annexe 3.1-3.5; **Fig. 7**).[329]

Given these findings, a closer look at the role of tables and quantitative graphs in French lithic inquiry is warranted. What is their purpose and how do they relate to object-images? I will use Boëda's (1988) study as an illustration again. The first point to note is that the few quantitative graphs that this study features represent a follow up of the qualitative examination of the main core reduction schemes. This positioning is not at all coincidental. The 'imaging task' that they perform, namely to quantify metric values of cores, is *dependent* on the preceding technological analysis (cf. *ibid.*: Fig. 18.13-18.14). Quantified are simply the categories that have been established before (*Schémas A-C*, *Indifférencié*). In contrast to the Anglophone case studies in which quantification is clearly a primary operation, quantitative analysis is secondary and serves to investigate category-internal dynamics, as well as the quantitative effects, if any, of these categories.[330] The design and content of tables follow a similar logic. Here also the goal is to analyse and cross-tabulate the distribution of 'synthetic,' that is, already established whole-categories in order to learn something about their interconnectedness (cf. *ibid.*: Tabl. 18.I-18.V [Table 5 *sic!*]), for example to provide insight into the 'infrastructural' details of a *given* technical system.[331] This operation is diagnostic rather than prognostic; it proceeds from wholes to parts and not the other way around. Therefore, most non-object visualisations *presuppose* whole-categories. The respective graphs and tables demonstrate that the significance of parts is determined by their place in a whole – a classic tenet of 'synthetic' thought.

This configuration of visual practice may also explain why there is so much heterogeneity in terms of using different graphs, tables, and object representations in French technological research. The images called upon vary because they have to express different arguments and different kinds of technical relationships depending on the assemblage-level context in question. In other words, to highlight the relevant technological relationships may require to summon different 'image-types' and to adapt them specifically to the argumentative and inferential demands of particular contexts of inquiry.

The last aspect of French visual practice that requires some attention is the deployment of relatively abstract diagrams and schemas – in particular because this 'image-type' is often completely missing in Anglophone scholarly productions. The 'synthetic' quality of this type of imagery is immediately evident. The 'imaging task' is to visualise the *technological functioning* of a lithic whole in question. The respective images may for example specify the volumetric 'working principles' of a prepared Levallois core (Boëda 1988: Fig. 18.1) or bifacial shaping (Boëda 1995a: Figure 1-4), how a core is transformed in terms of its morphology and surface configuration as a function of particular blank

[328] This type of additional, symbolically encoded visio-technical information seems to be very rare in the Anglophone lithic literature. Even simple technical arrows indicating the direction of removals are sometimes missing, especially when plain *débitage* or tools are concerned (cf. e.g., Shea 2013a, 2017a; Stutz and Nilsson Stutz 2017: Fig. 32.2). This exclusive focus on artefact *outline* suggests that the images serve a purpose other than showcasing these features or that these features are generally not regarded to capture important information – it again indicates that object imagery primarily serves dispensable, 'illustrative' purposes.
[329] But see Dauvois (1976: 129-139). Already Dauvois (*idem*), the father of the *schéma diacritique*, speaks of "dynamic and structural drawings." His vision of drawing is thus already 'synthetic.' Drawing a lithic object always implies to interpret the object in the light of its parts and its parts in the light of the object's 'wholeness.' A 'dynamic and structural drawing' captures the insights gained through this process. Note also that devising a *schéma diacritique* essentially *requires* to visualise the target object. Some form of visualisation is therefore indispensible for this type of technological inquiry.
[330] In a more recent paper, Boëda et al. (2014: 955) explicitly note: "[...] [t]he underlying and more significant question concerns the concept of cobbles – their form and volume, and the ways in which natural features of the raw material may have been incorporated in reduction sequences leading to tool production. This is essentially a qualitative question that requires technological and technical analysis that cannot be reduced to simple numbers and graphs."
[331] This notion of 'infrastructure,' certainly central to some strands of 'synthetic' technological thought in France, will be explored in more detail in the first part of Chapter 5.

detachments (cf. Boëda 1988: Fig. 18.2), or how different reduction stages are orchestrated and what kind of lithic products each of them supplies (cf. *ibid*.: Fig. 18.22).[332] These visualisations involve a certain degree of abstraction and idealisation and seek to capture the *systemic articulation* of various technological elements. This can result in hybrid images where idealised exploitation schemes are juxtaposed with object-particulars in order to demonstrate that the latter form a unified technical whole (cf. Soriano 2000: Fig. 99-100); it can equally result in complex diagrams, often also hybrid in character, which specify the system-level relationships between different lithic artefacts and their features (**Fig. 8**).[333] More abstract and 'diagrammatical' images may for instance represent the relationship between different lithic production systems within an assemblage without comprising any iconic component (cf. Boëda 1995a: Figure 20).[334] All of these images depict something that cannot directly be observed in the examined assemblages. There exists no spatiotemporal physical object that corresponds to them. We have to conclude that they are purely *conceptual images*. The fact that they play such an important role in all of the three case studies thus further supports the claim that French technological research can be understood as a *conceptual practice*.[335] The goal of conceptual images is to provide conceptual 'understanding.'

It has to be said, however, that 'diagrammatic reasoning' –that is, the understanding of concepts and idea by means of visual devices (e.g., Kulpa 1994; Anderson et al. 2002) – is not completely foreign to Anglophone approaches. Already Clarke's *Analytical Archaeology* (1968) musters a whole range of abstract diagrams and Shennan's *Quantifying Archaeology* (1997 [1988]) also includes such imagery. Yet, the difference is that these images are *theoretical entities* in the sense of 'theory' specified in the previous section. They serve a rather different purpose than the conceptual images found in the French discourse. Their 'imaging task' is to formalise and simplify theory-derived expectations (e.g., Clarke 1972b: Fig. 1.4, Figs. 1.9-1.11, Fig. 1.17; Ambrose and Lorenz 1990: Fig. 1.1, 1.2) or to provide an overview of the various causal or otherwise constitutive relationships that hold together different domains of reality (e.g., Binford 1980: Figure 1, 3; Rolland and Dibble 1990: Fig. 13; Nelson 1991: Figure 2.1; Jochim 1992: Figure 1; Hoffecker 2002: Fig. 1.6; Steenhuyse 2007: Fig. 1.1). Theoretical quantitative-statistical images represent 'ideal' patterns and data-behaviours against which empirical findings can be compared. Theoretical images of worldly-order typically legitimise correlative thinking and the explanation of certain phenomena (e.g., lithic technology) in terms of other phenomena (e.g., climate change).[336] Alternatively, abstract imagery may serve to explain measuring procedures; it may also be deployed in experimental lithic research in order to describe the study design or the specific causal-determinative factors investigated. In all of these cases, however, diagrammatic reasoning serves or prepares empirical data-analysis, it is almost never an active part of this analysis.[337] Moreover, these images almost always 'theorise' parts and their configurations, co-variations, and transformations – their goal is 'explanatory.'

How images are *produced* is no less informative. Automated image-production by specialised expert software, for instance, seems to be a hallmark of Anglophone lithic practice (e.g., Braun and Harris 2001), especially when complex statistical procedures are employed or a geometric morphometrics approach is followed (cf. Shott and Trail 2010; Archer et al. 2017; McPherron 2018). An important aspect of this imagery is that the distance between data-input and data-visualisation is fairly small.[338] The visualisation typically follows by necessity from the data-input. All of this is thought to secure an 'objectivist' analysis of the evidence (cf. McPherron 1991; Lycett and Cramon-Taubadel

[332] This, conversely, also means that this 'synthetic' imagery serves to specify which parts of the assemblage are *relevant* for the reconstruction of particular sub-wholes such as tool-systems, reduction systems, and various significant artefact-groupings. Thus, the lithic wholes determine explanatory 'relevance,' not the parts.
[333] 'Hybrid' here simply means that drawings, photographs, and/or more conceptual diagrams and schemas are combined within a single image.
[334] See also Boëda et al. (1990), Geneste et al. (1997), and Bourguignon et al. (2004) for the utilisation of similar 'image-types' with broadly similar 'imaging tasks.'
[335] See the previous section for a similar point.
[336] If systemic 'imaging tasks' are chosen, the outlined systems typically specify *external* relationships, not so much the internal configuration of lithic technology.
[337] Certain types of 'digraphs' which are sometimes used to analyse lithic reduction trajectories (e.g., Kuhn [2014] 1995: Fig. 4.11) may be an exception here since they appear to 'summarise' empirical findings. I will address this issue in the second part of Chapter 5, when various versions of the 'reduction thesis' are scrutinised.
[338] This is because the software produces imagery based on *mathematical formulae*, *calculi*, or other principals of transposition, so that the relationship between the input and the output is well-defined.

2013),[339] even though some subsequent visual manipulation may nonetheless be necessary in order to render the image intelligible. The increasing use of 3D-rendering technology to display lithic objects is another case of a quasi-automated practice of visualisation (e.g., Bleed et al. 2017). But as Magnani (2014: 285) for example readily admits, the resulting images, for the most part at least, serve illustrative purposes and provide a precise 'visual record' of the objects in question. In the case of geometric-morphometrics imagery, a similar point can be made. These images, strictly speaking, do not specify primary data since this data is also provided in digits and other numerical measures.[340] In the French case, pictorial diagrams and even artefact-plates are also increasingly constructed with the help of graphic applications. But this process appears to be comparatively non-automated. Instead, the process of constructing images, depending on their pictorial and interpretive complexity, typically involves *tinkering* with different arrangements and pictorial elements until a satisfying image-composition has been established.[341] This image-making practice leaves room for personal idiosyncrasies, but also epitomises the 'synthetic' need to adapt visualisations to specific assemblage requirements. French lithic scholarship, especially the latest generation of researchers, indeed often puts much effort into designing lithic imagery. The latest monographs in the *CTHS* series exemplify this trend[342] – the pictorial investment they embody at times even rivals text-writing.

This increasing significance of the 'rhetoric of images' in French lithic inquiry is also echoed by a recent controversy between Sylvain Soriano and Ludovic Slimak about supposedly 'aestheticised' lithic object-imagery and its seductive potential (Soriano 2010; for the response, see Slimak 2010). The debate certainly indicates that the persuasive power of lithic imagery cannot be taken lightly anymore. Grégor Marchand (2017: 10), for example, has recently also evoked the epistemological importance of 'imaging practices' in Palaeolithic knowledge production:

> "I belong to the rarity of archaeologists who think – and hope – that one day, a good portion of the work on prehistory can be exclusively presented in images, in drawings, and in schemes." (my translation [for the original French quote, see **Appendix Q.7**]) (Note his omission of graphs and tables here!)

Taken together, the evidence clearly suggests that the visualisation of objects, concepts, and data constitutes a key practice in lithic research. The detailed examination of visualisation trends in French and Anglophone approaches has thereby established that image-practice follows a vastly different logic in the two camps. While lithic image-use in the latter is guided by 'analytic' imperatives, the construction and implementation of imagery in the former serves to facilitate a 'synthetic' understanding of lithic technology. The revealed differences reproduce many of the fault lines between the two research spheres that have been identified and discussed in the previous sections, confirming that we are dealing with a robust and coherent pattern. One can thus conclude that the difficulties of bridging the French-Anglophone divide are likely related to the complications of negotiating between 'analytic' and 'synthetic' visions of science. Although the issue appears to be fairly general from this perspective, it should have also become clear that these two general research orientations are *realised* in rather specific ways, acknowledging the unique questions and problems of lithic inquiry in Palaeolithic archaeology. A short excursion into the realm of empirical discourse will provide sample material to better understand some of these more tangible ways in which the 'analytic'-'synthetic' divergence continues to impact Palaeolithic research.

---

[339] Lycett and Taubadel (2013: 1509), for example, emphasise that morphometric approaches provide 'far more than merely an image capturing technique' and offer "an automatic method of analysis." See also Archer et al. (2015, 2016: 61) for an accentuation of the importance of 'automated approaches' in lithic studies.

[340] To be more specific here, the 3D-image is used to extract the sought-for data. This, just like in the case of physical lithic objects, suggests that the images are considered evidence rather than data. They first have to be transposed in a normalised data-format in order to become data.

[341] I would in fact argue that this process of image-construction cannot be separated from the process of data-analysis since the construction of the image may provide insights which are otherwise difficult to gain and deepen the investigators understanding of the assemblage-whole. Working with and constructing images becomes therefore another means of holistically making sense of a particular lithic context. This inseparability of understanding and image-making affirms the 'synthetic' quality of inquiry in the French scene. I do admit, however, that an 'ethnography of lithic image-making' would be necessary in order to substantiate this perspective.

[342] Some recent studies published in the *Éditions du Comité des travaux historique et scientifique* monograph-series suggest that image and text are increasingly seen as equally important in French lithic research. These monographs are extremely well illustrated and the image quality is extremely high. Langlais' *Les Sociétés Magdaléniennes de L'Isthme Pyrénéen* (2010) and Mevel's *Des Sociétés en Mouvement. Évolution des Sociétés Magdaléniennes et Aziliennes des Alpes du Nord Françaises* (2017) are revealing examples of this trend.

3.2.5 *Two key sites of lithic conflict: variability and complexity*

Variability and complexity are the subject of lithic research since the field's inception. Their investigation can be regarded as part of the core business of Palaeolithic archaeologists, and insights into these two aspects of lithic technology generally promise to make an important contribution to our knowledge of the deep human past. It is therefore not surprising that both French and Anglophone lithic researchers have always endeavoured to tackle questions of variability and complexity. Both would agree that progress in the field to a certain extent depends on our ability to better comprehend and disentangle these two key coordinates of the lithic record. Lithic variability and technological complexity thus present themselves as excellent candidates for a comparative conceptual analysis. How are these two terms usually understood and examined in the two research spheres? And how does this effect what we can know about the Palaeolithic and its technological evolution? What follows in this last section is an attempt to address these questions and to investigate to what extent different answers may be explained with reference to Pepper's divarication between 'analytic' and 'synthetic' cognition. The foregoing analysis clearly suggests that such an investigation should be both worthwhile and clarifying.

Variability: the ''oligarchic' vs. the 'democratic' point of view

How is the variability of lithic technology conceptualised? How is it measured and monitored in order to determine its significance? In general terms, variability describes how closely related or spread out a set of data is. The concept seeks to capture to what degree a particular entity can vary as a function of different variables. It is therefore obvious that empirical measures of lithic variability depend upon the mobilised kinds of data and the technological entities considered to vary. The question of variability is therefore interwoven with questions about data-concepts and the appropriate unit of analysis, issues which have already been covered in the previous sections. For this reason, it seems appropriate to begin with a survey of terms and concepts invoked in the literature to approach or assess lithic variability in particular research contexts. What is their presumed level and focus of analysis?

In the French case, variability is usually assessed on multiple levels. It can be discussed on the level of lithic assemblages, significant sub-units of these assemblages, or on the level of particular technical objects, for example bifaces. The central point, however, is that the variability discourse is anchored in the identification and discussion of entities that have no direct physical or artefactual correlate. When variability is debated, French lithic experts typically conjure concepts such as *chaînes opératoires* (e.g., Pelegrin et al. 1988; Boëda et al. 1990; Julien 1992; Pelegrin 1995; Geneste et al. 1997) 'technical systems' (*systèmes techniques*) (e.g., Perlès 1987: 22; Boëda 1991; Inizan et al. 1995: 14f.; Bodu et al. 2001; Geneste 2010 [1991]; Valentin 2011: 46),[343] modalities of volume-management (*conceptions volumétriques*) (e.g., Boëda 1993, 1994; Bodu 1994; Valentin 1995: Annexes; Bourguignon 1997; Delagnes and Roche 2005), gestural systems (e.g., Pigeot 1987; Le Brun-Ricalens 2005: Fig. 9, 14; Koehler 2011: Fig. 11; Valentin et al. 2014; Marchand 2014: Fig. 37), 'technical logic' (*logique technique*) (e.g., Perlès 2009; Brenet and Folgado 2009; Chevrier 2012: 769f.),[344] *schémas opératoires* (e.g., Boëda 1986, 1994; Pelegrin 1990, 1995; Boëda et al. 1990; Karlin and Julien 1994), or 'knowledge' (i.e., *savoir-faire*, *connaissance*, *vouloir-faire*, skill, and technical competence) (e.g., Pigeot 1983, 2004; Ploux 1988, 1991; Karlin 1991; Pelegrin 1991, 2000; Audouze 2010; Ploux and Karlin 2014; Leroyer 2016). More recently, 'tool systems' have been faithfully added to this list (e.g., Boëda 1991, 1997, 2013; Lepot 1992/1993; Soriano 2000; Bonilauri 2010; Nicoud 2011; Chevrier 2012). Even if scholars wish to study lithic variability on the level of social and economic strategies (e.g., Perlès 1980, 1991b, 1992; Bon 2002, Pelegrin 2011; Renard and Ducasse 2015), these strategies are reconstructed with reference to some of the listed categories.

What emerges from this general enumeration of terms and concepts is the recognition that variability in the French scene is interrogated on some *higher level* of lithic organisation. Most of the

[343] See already Mauss (1947: 29). [cited in Inizan et al. 1999 [1995]: 14, footnote 14]
[344] See also Boris Valentin in [*Devenir Archéologue*] *Les outils en pierre préhistoriques*, uploaded to the YouTube network by the University of Paris I-Sorbonne on the 9th of February 2016 [URL = https://www.youtube.com/watch?v=MB4CD145z40].

time, the relevant variability is even located within *virtual* properties of lithic technology – that is, properties that refer to an 'ideal' aspect of technical reality that is nonetheless real.[345]

There are two immediate consequences of this discursive configuration. The first is that one is not only prompted to examine the variability within these categories, but also the variability *between* them – that is, how the various categories are interconnected and linked in a given technical context, i.e., in a particular lithic assemblage. The distinction between 'technique,' 'method,' and 'concept,' introduced during the 'technological revolution' (cf. Tixier et al. 1980; Perlès 1991a), resonates with this ambition. The classic preoccupation of French technological inquiry to reconstruct 'operational schemes' and to relate them to their corresponding 'conceptual schemes' in order to retrace distinct 'knapping projects' can similarly be regarded as a symptom of this basic understanding of variability (cf. Schlanger 1994; Pelegrin 1995; Inizan et al. 1999 [1995]: 15). Variability, in this view, is always a multi-scalar and multi-dimensional phenomenon (cf. Forestier 1993: Fig. 1):

> "Because lithic variability is not exclusively typological, but simultaneously conceptual, technical, and economic, it is also likely that the underlying factors are themselves of a varied nature. Although most archaeologists would assent to this proposition, few actually apply it to their analyses of lithic industries. Instead, most diachronic and synchronic studies postulate single "explanatory" factors – e.g., functional needs, seasonality of occupation, cultural traditions, etc. – and account for all observational data in light of these "hypotheses." Such approaches are necessarily at the methodological level to the extent that they demonstrate the *potential* relevance of a given factor. On the other hand, these approaches lack the capacity to discriminate among various causal factors. Such arguments cannot establish either that the factor under consideration accounts for *all* of the observed variability or that it *alone* could produce it. Consequently, these approaches are too restricted for an efficient analysis of archaeological contexts in which lithic industries, their variations, and their transformations result, as do all human phenomena, from the interaction of multiple factors." (Perlès 1992: 24; original emphasis)

The second consequence is that artefactual variability cannot be compared without reference to these higher-level categories anymore.[346] The goal of technological analysis is to resolve the variability of lithic artefacts *internally*, that is, in terms of reconstructing effective technical groupings or contexts, so that the higher-level categories can be filled with technological content. To resolve the variability of Levallois assemblages, for instance, not only implies to show how many different varieties of Levallois reduction can actually be found in the respective assemblages, but also demands one to enquire whether apparently disparate sets of lithic artefacts (in terms of frequency distributions, metrics, present tool-types, etc.) may nonetheless 'belong' to the same technological variety.

All of these observations suggest that French researchers tend to study lithic variability through the prism of 'synthetic' categories. Newer attempts to chart aspects of variability in terms of abstract 'technological structures,' for instance, equally testify to the fact that the subject is approached from the perspective of wholes rather than parts (cf. e.g., Boëda 1997, 2005; Forestier 2000, 2010; Nicoud et al. 2016). These technical wholes are thought to have properties of their own and it is these properties that constitute the primary focus of analysis. With Pepper, we can say that variability turns out to be question of 'relations,' 'qualities,' and 'nexuses.' The resulting 'synthetic' understanding entails the concession that 'knowing the variability of lithic parts may mean nothing without knowing how it relates to the variability of the corresponding wholes.' As a result, the variability discourse in French Palaeolithic archaeology appears to be directed by an *oligarchy of wholes*.

This oligarchy of wholes is countered by a *democracy of parts* in Anglophone lithic research. In the latter, variability is assessed by charting and, if possible, quantifying part-based 'attributes,' 'traits,' and other directly observable variables. Variability is understood foremost as a non-stable pattern or structure of lithic data, fluctuating in relation to some relevant independent variables – it is primarily seen as a *quantitative* phenomenon. Variability, in other words, is the *result* of the various interactions, combinations, and associations of the relevant lithic parts and their features – it is the *outcome* of part-centred analysis. Lithic variability is therefore simply defined as a consequence of

[345] This findings clearly hints at the important role of *interpretive idealisation* in French lithic research. Although I cannot provide an in depth analysis of this research operation here, we will touch upon this issue again in Chapter 5.
[346] In other words: artefactual variability, that is, the variability found in the lithic artefacts themselves, cannot be taken as an *absolute* measure. It needs to be 'calibrated' against their technical whole or at least 'put into perspective' by this whole.

varying constellations of 'particulars,' 'characters,' 'ties' or other 'primary' and 'secondary' part-qualities. This conception is overwhelmingly 'analytic.'

Anglophone scholars typically map different types of variability depending on the type of data they harness. We may for example distinguish between *typological variability* (e.g., Freeman 1966; Wymer 1968; Sackett 1973, 1999; Rolland and Dibble 1990: 492; Dibble 1987; Coinman and Henry 1995; Mellars 1996; Szmidt 2003; Wenban-Smith 2004; McPherron 2006; Olszewski 2016), *morphological variability* (e.g., Sackett 1966; Roe 1968; McPherron 1994; White 1998; Iovita 2008, 2011; McPherron and Iovita 2011; McNabb and Cole 2015), *raw material variability* (e.g., Rolland 1977; West and Montet-White 1990; Ambrose and Lorenz 1990: 21-24; Jelinek 1991; Dibble 1991b; Kuhn 2004b, 2011: 100-102), and combined or other more specific axes of trait-based variability (e.g., Barton 1988: 105-110; Kuhn 1995; Tostevin 2000, 2012; Marks et al. 2001; Henry 2003; McCall 2006, 2015; Wragg Sykes 2009; Scott 2011; Culley et al. 2013; Ruebens 2014; Monnier and Missal 2014: Table 2; Scerri et al. 2014; Conard and Will 2015; Jones 2016; Ruebens and Wragg Sykes 2016; Rezek et al. 2018). There is no general hierarchy between these axes of variability, and they, as a result, may be analysed as parts themselves – the aim is then to examine their *external* relatedness and, if possible, to detect patterns of co-variation and (statistical) correlation. Contrary to the French conception, the idea here is that 'knowing the variability of the whole is largely identical with knowing the variability among lithic parts.' A key precondition for studying variability on an inter-assemblage level is thus to keep the analytical part-categories constant. The result is a strong analytical reliance on well-defined and standardised systems of object classification and similarly formalised trait-lists.[347]

On the assemblage-level, variability is generally examined as the degree of similarity or affinity. There are a number of schemes for organising variability at differing scales, but all of them organise the data according to some logic of increasing or decreasing affinity, analogy, or resemblance among parts. The perhaps most well-known scheme of this type is Clarke's (1968: 187-189, Fig. 40) 'hierarchical model of archaeological entities' – a model that is still frequently used today (e.g., Gamble 2001: 52; McNabb 2007: 7-9; Shea 2013a; 37f.). Clarke discriminates between 'attribute,' 'artefact,' 'type,' 'assemblage,' 'culture,' 'culture group,' and 'technocomplex.' While one climbs up this hierarchical ladder of categories, the relevant part-affinities decrease (which means that their variability increases), but the spatial and temporal coverage of the categories simultaneously increases. Clarke' model for organising lithic variability is often used in a simplified version, distinguishing merely between 'assemblage,' 'assemblage-type,' and 'assemblage-tradition' (cf. McNabb 2007: 7-9). An 'assemblage' is here defined as a shared set of significant attributes, an 'assemblage-type' consists of a series of assemblages that share these significant attributes, and an 'assemblage-tradition' is encountered when assemblage-types persist through longer timespans. Drawing on Pepper, this understanding of the general structure of variability can be said to imply 'The Theory of Types' and/or set-theoretical premises.[348]

Williams' (2003: 92-95) framework to assess lithic variability in the Levantine Early Upper Palaeolithic follows a similar logic. Based on the classic work of Henry (1989a: 81-89) and Marks (2003), he differentiates between three lithic entities – 'complex,' 'industry,' and 'phase/facie' (**Fig. 9**). Again, these categories are thought to capture different levels of variability, the relationship between the categories being defined as decreasing inter-assemblage affinity measured by the individual characteristics of the lithic artefacts that take part in the assemblages (cf. Williams 2003: 94f.).[349] The logic of determining variability and organising it is clearly 'atomistic.' The basic strategy is to start with the smallest elements and gradually built up ever larger groupings of such elements – the regulative idea is the 'law of association' (see Chapter 2). The 'smallest' parts are examined in order to detect robust patterns or other new wholes; these patterns or wholes are then 'turned' into parts themselves and analysed in order to establish new patterns and wholes, and so on. The structure of variability is reconstructed 'bottom-up' and the higher levels remain in principle reducible to the basic elements that generate them.

[347] See the Section 3.2.1.

[348] See Chapter 2 for a discussion. See also Pepper (1942: 156-162).

[349] This logic of mapping lithic variability enables the discrimination between multiple levels of organisational hierarchy. These levels are typically referred to as 'higher-order groupings': "[h]igher-order groupings of stone tools consist of a hierarchy of technological and typological characteristics, artifact-types, assemblage-groups/industries, and industrial complexes." (Shea 2013a: 37)

These short enunciations are enough to reveal that French and Anglophone approaches to lithic variability appear to be informed by opposite ends of the 'synthetic'-'analytic' spectrum. The survey of the various terms and categories that form the bedrock of studying variability in both camps has demonstrated that not only the mustered categories themselves differ, but also the ways in which they are put to practice. It has become clear that these differences have a strong impact on how the lithic record is perceived and understood, with important implications for the possibilities of lithic interpretation and knowledge formation. The exposition has therefore clarified some of the stakes of the French-Anglophone divide and further ratifies that Pepper's epistemological categories are likely well-suited to unpack it.

Complexity: compositionality vs. systemic emergence

How is technological complexity defined and assessed? What are the key differences between a 'more complex' and a 'less complex' technological make-up? What are the relevant units and the preferred focus of analysis to examine complexity? The term 'complexity' is typically employed to characterise an entity with many components interacting in multiple ways. These interactions 'create' complexities of various sorts. It is therefore the relationship between parts, their linkages, and the 'complex' whole they delineate that is central for any understanding of complexity as a phenomenon. Various notions of complexity are thus likely to favour their own definitions of these elements and their connections. If we wish to investigate the key concepts that guide the empirical examination of complexity in France and the Anglophone world, we consequently have to pay attention to these three aspects. We have to ask how lithic complexity is build up, what its building blocks and what its consequences are.

The basic orientation of Anglophone complexity research is expressed by Perrault et al. (2013), who assert that

> "[…] the complexity of a technology can be measured by counting the number of elemental building blocks associated with it." (*ibid.*: 398)

The strategy is almost always to determine the boundaries of whatever one wants to analyse in terms of complexity, decompose it into its relevant parts and then re-assemble these parts again. The 'Golden Rule' employed by many of these approaches can be summed up in the following manner: 'the more relevant parts can be observed, the more complex the phenomenon under consideration appears to be.'[350] Whether the respective parts are identified as 'procedural units,' 'tool categories,' or 'concept traits' may of course differ, yet in all cases complexity is considered an *aggregate property* of technological wholes, especially lithic assemblages (cf. Bousman 1993; Torrence 2001: 78).[351] Rather importantly, the complexity of the whole thereby follows without loss from the whole's compartmentalised part-structure. The result of this research configuration is a strong predisposition of picturing the evolution of lithic complexity either as a story of qualitative changes based on the presence or absence of certain key traits (e.g., Ambrose 2001, 2010; Brooks et al. 2006; Coolidge and Wynn 2009; Shea 2009; Shea and Sisk 2010) or primarily in quantitative terms, so that a continuous evolution of more or less complex technologies becomes conceivable. Examples for the latter approach are Isaac (1972, 1976), Dennell (1983), Mellars (1989, 2006: xii), McGrew (1992), Gowlett (1996: 154, Fig. 5.9), Per-

---

[350] This orientation is also reflected in the general definitions of complexity employed to direct the 'human modernity' discourse: "Behavioural complexity is defined relatively as the accumulation of 'more parts and more connections between parts' in cultural systems (Price 1995, 140), whereas symbolic thought can be defined as 'the ability to represent objects, people, and abstract concepts with arbitrary symbols, vocal or visual, and to reify such symbols in cultural practice' (McBrearty & Brooks 2000, 492). Combining both of these definitions, we define complex behaviour here as that which requires successive cognitive components that demand the actor to plan several consecutive steps (such as those used in the manufacture of multi-component artefacts) before the execution of the first step, or which require deep understanding of the operation of variables and their complex interplay as well as their reactions to deliberate manipulations by the actor. This last part of the definition refers to understandings of environment and the operation of the natural world that facilitate, for example, catching deep water fish, making repeated sea crossings and navigating between islands or intentionally influencing the natural reproductive cycles and productivity of plants and animals." (Langlais et al. 2008: 291)

[351] Torrence (2001: 78), for instance, defines 'complexity' in tandem with other composite properties of lithic assemblages: "Tool assemblage structure is described in terms of the particular mix of tool types (*composition*); number of types (*diversity*); and number of parts of each tool (Torrence 1983) or the average number of parts per tool in an assemblage (*complexity*) (Bousman 1993, Bamforth and Bleed 1997)." (original emphasis)

reault et al. (2013), Gamble et al. (2014: Fig. 3.4), or Hoffecker and Hoffecker (2018).[352] Most of these approaches are implicitly or explicitly inspired by common definitions of complexity in biology (e.g., Bonner 1988) or the behavioural sciences (e.g. Cochet and Byrne 2015). Some of the reasons for this conceptual affinity are historical. Anglophone scholars, especially those engaged with the 'behavioural modernity' debate, have tended to use complexity arguments in order to negotiate the boundary between 'animality' and 'humanity,' as well as between 'nature' and 'culture' (cf. Corbey 2005).[353] An important epistemological ideal of all of these definitions is that they aspire to be 'objectivist' and to facilitate an *absolute* understanding of lithic complexity that is valid independently of the context of inquiry or the technology in question.

Furthermore, and as Kuhn (2011: 104) for instance also notes, most discussions of lithic complexity refer to or depart from the seminal work of Wendell Oswalt (1974, 1976). Based on ethnographic observations and parallels, Oswalt proposed that technological complexity can be assessed by comparing the number of 'technounits' that different technologies host. A 'technounit' is thereby defined as an "integrated, physically distinct, and unique structural configuration that contributes to the form of the finished artefact" (Oswalt 1976: 36). A simple wooden digging stick, for example, has only a single 'technounit,' whereas composite harpoons and other hunting weapons usually consist of multiple 'technounits' (cf. Kelly 2013: 120). Measuring technological complexity with reference to 'technounits' enables, on the one hand, to obtain a rough measure for the overall complexity of the assemblage – what Oswalt termed the *elaborateness* of technology – and, on the other, to assess the complexity of individual tools. The latter provides insight into the variability of tool-complexity *within* a given assemblage. 'Simple' tools, according to Oswalt (1974), have parts that do not change their position relative to other parts during use, whereas 'complex' tools do alter the position of their parts during utilisation. It is easy to see that this account of complexity is 'analytic' – it revolves around lithic parts, potentially relates and counts them. Moreover, a 'part' may consist of multiple parts itself. It is generally sufficient to assess the configuration of these parts in order to gauge the complexity of the technological whole to which they contribute. The complexity of the whole, in other words, is always reducible to the characteristics of the relevant parts. As a result, Anglophone scholars who draw on Oswalt's theory typically inherit his 'analytic' conception of complexity (cf. e.g., Torrence 2001: 78f.; Kelly 2013: 116-128; Hoffecker and Hoffecker 2018: 203-206, 222f.).

It should also be noted that Oswalt's focus on 'food-getting technology' laid the groundwork for a whole suite of *Human Behavioural Ecology* (HBE) approaches which conceive of technological complexity as an expression of forager adaptations to northern latitudes (e.g., Hoffecker 2001, 2005; Reed 2008). Through this prism and in line with Oswalt's original considerations, technological complexity is seen to "reflect the complexity of the problems that it was designed to solve" (Hoffecker and Hoffecker 2018: 217). This view is compatible with 'optimality' and 'risk-centred' approaches which play an important role in the current Anglophone discourse (cf. Bleed 1986; Torrence 1983, 1989c, 2002; Jochim 1983; Bamforth and Bleed 1997).[354]

Even though the scope of this survey is certainly limited given the importance of the complexity question in Anglophone debates, the discussion nevertheless demonstrates that there exists a strong tendency to reconstruct complexity in 'analytic' terms and to regard the object of complexity as a *compositional entity*. The analysis of complexity tends to focus exclusively on parts and part-properties. In general, the applied definitions thereby seem to cover only a small fraction of the possible spectrum of complexity definitions (but see Hoffecker and Hoffecker 2018).[355]

In French technological research, by contrast, questions of complexity are typically pursued on the level of significant technical wholes. This means that complexity is either gauged relative to some

[352] The recent paper by Muller et al. (2017) falls into the same category of approaches, even though the authors cannot be considered here.
[353] Because of this focus on significant evolutionary transitions, many workers have in fact adopted what Vaesen and Houkes (2017: 1246) call the 'complexity thesis,' which holds that "cumulative technological complexity is a distinctive characteristic of human cultural evolution."
[354] See the second part of Chapter 4.
[355] The comparison of the discussed Anglophone understandings of complexity with Vaesen and Houkes' (2017) Table 1 shows that only three, perhaps four, of the nine listed conceptions of complexity (definitions nr. [1] and [2], perhaps nr. [3] and [6]) are currently applied to the empirical data (cf. **Appendix III.3: Table III.1**). It should be noted that Anglophone research also relies on omitted definition nr. [10], which was originally termed 'adaptive complexity.' Even though some of the listed definitions are difficult to operationalise within a strictly 'analytic' framework of inquiry, others could have easily been adopted. This at least indicates the potential of future conceptual work in this domain.

(higher level) properties of the whole which its parts lack, or as a function of interconnections between parts that cannot be discovered by an analysis of patterns among part-properties alone. The examination of technological complexity, in other words, is guided by the intuition of strong *systemic emergence*. Complexity, in this view, is a property of wholes that cannot be reduced to the properties of their parts – an 'emergent' property resulting from 'non-additive' and 'non-predictable' processes.[356] Discussing the concept thus reveals important parallels with the French understanding of variability.[357] In a now largely forgotten paper on the issue of *chaînes opératoires* in the animal kingdom, Beyries and Joulian (1990: 23) for example emphasise that one cannot meaningfully talk about complexity in the singular, because in reality one always deals with *multiple complexities* simultaneously. The same authors also stress that complexity is about the 'integration and level of management of functional, technical, economic, ecological, and cognitive factors' of behaviour (*idem*).[358] All of this mirrors what we have found previously, foreshadowing a relational approach to technological complexity. While introducing the problem of applying the *chaîne opératoire* approach to animal behaviour, Beyries and Joulian (*ibid.*: 17) also indicate that *chaînes opératoires*, and *a fortiori* their complexities, 'cannot be described or analysed in an absolute manner.' Already on a general level, therefore, they reject an overly 'objectivist' account of technical complexity.

The first important axis of investigating complexity in the French research context is the study of varying modalities of managing a volume-matrix. This, for instance, may involve questions about the relationship between preparation and reduction, the technical demands of 'navigating' a particular core architecture or adapting to certain local rules of reduction, the need of altering technical gestures, the requirements of rotating cores or reorganising their volumetric structure, the level of redundancy or 'cyclicity' involved in the reduction process, or the dependency on technical anticipation (cf. e.g., Binder and Perlès 1990; Boëda 1991, 2005, 2013; Mourre 2003; Pigeot 1991; Bourguignon et al. 2006; Valentin et al. 2014). In most cases, the goal is to determine the co-constitutive relationships that exist between some or all of these factors. The important point, however, is that none of these factors can be examined by interrogating lithic parts in isolation. Rather, all of the mentioned factors describe qualities of 'operating' technical systems. They result from the dynamic interplay of technical knowledge, reduction methods, and knapping techniques. Whether one of these factors renders the system 'complex' and in what respect *depends* to a large degree on the system itself (i.e., its organisation).

The second axis of researching complexity concerns the structure of the *chaîne opératoire*. The idea here is that different ways of organising the knapping process lead to different 'infrastructures,' that is, different articulations of groups of artefacts and technical operations. Geneste (2010 [1991]: 429-432, Fig. 1, 2), for example, distinguishes between 'linear,' 'scalariform,' and 'ramified' reduction structures (**Fig. 10**). These may also be combined to form 'hybrid' reduction structures and the respective structural qualities may be expressed to varying degrees (cf. Boëda et al. 1990; Geneste et al. 1997; Bourguignon et al. 2004). Brenet (2011: esp. Fig. 8), in a similar vein, discriminates between 'independent' operational sequences (*chaînes opératoires indépendantes*), 'successive' operational sequences (*chaînes opératoires successives*), 'simple ramified' operational sequences (*chaînes opératoires ramifié simple*), 'mixt ramified' operational sequences (*chaînes opératoires ramifié mixte*), and two different types of operational sequences 'combining' *débitage* and *façonnage* (*chaînes opératoires combinée débitage/façonnage*). All of these categories delineate whole-qualities – they concern the globality of the technical processes which define a *chaîne opératoire*. The underlying conception of complexity is consequently 'synthetic.' Perlès' (1980, 1991b) and Boëda's (1991) concept of 'complex' operational sequences (*chaînes opératoires complexes*) supports this view: a 'complex' reduction trajectory is thought to follow relatively rigid and non-redundant rule-sets, whereas a more 'simple' system of reduction is typically characterised by a limited number of highly versatile technical rules.

The third axis of examining complexity concentrates on the nature of the wider 'technical milieu' in which specific technologies make their appearance. Instead of paying attention only to the internal constitution of particular *chaînes opératoires*, the various relationships between them come to fore here. Researchers can for example investigate the number of co-occurring technologies and

[356] See esp. Hodgson (2000) for a discussion of the history and significance of the concept of 'emergence' in the social sciences.
[357] See the previous sub-section.
[358] This provisional definition of complexity is consistent with definitions nr. [5] to [8] of Vaesen and Houkes' (2017) Table 1 (cf. **Appendix III.3: Table III.1**), indicating that we should expect little overlap between French and Anglophone concepts of complexity (see previous footnote).

whether or not they serve similar functional, economic, or social purposes (cf. Bourguignon et al. 2006).[359] The variability of reduction systems can therefore already be a potent proxy for the technological complexity of the assemblage in question. Another angle of inquiry focuses on the interactions and potential complementarities between broader categories of lithic technology – i.e., *débitage*, *façonnage*, and tool-technology (e.g., Boëda 1991, 1995a, 1997; Soressi 2002; Montoya 2004: Fig. 134; Boccaccio 2005: Fig. 159; Renard and Geneste 2006; Brenet and Folgado 2009; Ducasse 2012: Fig. 4). The objective is to determine inter-technology 'synergies' as well as the reality and extent of a technological 'division of labour' (e.g., Soriano 2000; Brenet et al. 2014). Asking broadly similar questions, other researchers have started to examine the link between particular production systematics and the utilisation of their associated non-retouched products (e.g., Soressi and Hayes 2003; Lazuén and Delagnes 2014). All of these perspectives highlight that technological complexity can only be understood adequately if the dynamic interplay between lithic parts and wholes is taken seriously.

More generally speaking, French technological scholarship exhibits a strong tendency to assess the various ways in which different dimensions of complexity appear to condition each other. An example is Roche and Texier's (1991) mediation of a possible link between the *conceptual complexity* and *operational simplicity* of *chaînes opératoires* – whether and, if so, under which conditions the two presuppose each other. Delagnes' (1995) classic discussion of trade-offs between simplicity and complexity at the interface of 'operational schemes' (*chaînes opératoires*) and 'conceptual schemes' (*schemas opératoires*) follows a similar logic of research. Complexity, therefore, is really understood as a multidimensional phenomenon that needs to be approached holistically.

Due to this multidimensionality of complexity, there is also no way of settling the complexity question once and forever. Moreover, complexity cannot even be defined in general terms and French scholars are typically somewhat sceptical whether net differences in complexity between different technological contexts can be established reliably. As a consequence, practitioners either establish complexity as a *relative* property or discuss how complexity is *organised* within a well-defined technical context and what this may mean in terms of human behaviour (e.g., Delagnes 2010; Delagnes and Rendu 2011). Bourguignon et al. (2006), for instance, argue that it makes generally little sense to invoke a binary opposition between 'simple' and 'complex' production systems to understand the nature of technology in the French Mousterian. If one compares different reduction systems and investigates their socioeconomic repercussions, one usually finds that different aspects of these systems turn out to be 'complex' or 'simple.' This, in turn, suggests that complexity is a *dependent* property and that investing one dimension of complexity may have potential implications for its other dimensions (cf. Brenet et al. 2014). Although different techno-economic systems may therefore turn out to be 'complex' in rather different ways, every system will maintain a certain 'complexity equilibrium' – the total sum of a system's complexity will rarely change. The question, therefore, is not anymore how 'complex' a wider technical system is, but rather how its complexity is *distributed*. Clearly, this understanding motivates the default view that technical systems *are always complex in a certain sense*.

Technical complexity may be unequally distributed in a technical system because of social factors. It can for example be expressed as some kind of 'skillfullness.'[360] The latter may vary within a technical system because of reasons related to social learning and lithic apprenticeship (cf. e.g., Tixier 1976; Ploux 1983, 1988; Pigeot 1988a, 1988b; Karlin and Pigeot 1989; Ploux et al. 1991; Karlin et al. 1993; Delagnes and Roche 2005; Leroyer 2016). Different levels of complexity may consequently be the product of different levels of 'technical competence,' 'procedural knowledge' (*savoir-faire*), or 'conceptual knowledge' (*connaissance*) (Pelegrin 1991; Karlin and Julien 1994: 154). This perspective continues to be influential in French *« Palethnologie »*, which has traditionally endeavoured to expose and study 'micro-slices' of time.[361] Alternatively, complexity may be unequally distributed because of evolutionary reasons (cf. Pigeot 1991). Within the framework of Boëda's (1997, 2005, 2013) 'techno-genetic' paradigm, the character of technological complexity may considerably change in the course of long-term developments.[362] The basic idea is that lithic technologies organise themselves in 'technical lineages' when they navigate evolutionary time. In the earlier stages of technical development, tech-

[359] Note that the quantification of technical wholes remains a secondary operation since the wholes first need to be constructed by qualitative technological research.
[360] See definition nr. [4] in Vaesen and Houkes' (2017) Table 1 (cf. **Appendix III.3: Table III.1**).
[361] See the first part of Chapter 5 for a more detailed discussion of some of these issues.
[362] The generalities of the 'techno-genetic' approach are outlined and discussed in the second part of Chapter 5.

nologies are typically characterised by highly 'differentiated' and 'heterogeneous' structures – the relevant parts tend to operate independently from one another. In the later stages of technical evolution, by contrast, more and more 'integrated' structures emerge and these develop increasingly beneficial and mutually supportive inter-part relationships at potentially ever higher densities.[363] The character of this discourse is clearly 'synthetic.' Complexity is always analysed with reference to a technical whole, which appears to 'dictate' the terms under which something may be called 'complex' or 'simple.'

Altogether, the conceptual analysis of French and Anglophone complexity research can complement our previous findings. Complexity is mainly investigated from an 'analytic' point of view in the Anglophone world, whereas the majority of French technologists seems to adopt a 'synthetic' perspective. This recognition further substantiates the significance of Pepper's world theories for understanding the French-Anglophone divide and warrants an even closer examination of lithic practice on both sides. The question is now not only whether Pepper's 'analytic'-'synthetic' distinction has a general bearing on the divide, but rather whether the variability of approaches *within* both the French and Anglophone research enterprise can be illuminated by referring to Pepper's full spectrum of four world theories – 'formism,' 'contextualism,' 'mechanism,' and 'organicism.' We will explore this question in detail in the subsequent chapters.

[363] This conception of complexity is consistent with definitions nr. [7] and [8] of Vaesen and Houkes' (2017) Table 1 (cf. **Appendix III.3: Table III.1**).

Chapter 4

Analyticity unpacked: Anglophone approaches between formism and mechanism

"Hypotheses are developed to relate observed properties to one another by means of a structural concept. In this way an hypothesis, or an hypothetical model, is constructed for the sake of predicting certain correlated regularities"

– David L. Clarke (1968: 643)

"[...] [A]*ll factual knowledge of the archaeological record is created at the time persons make observations on the archaeological record. Factual knowledge, or knowledge claims regarding properties of the archaeological record are always contemporary with the observation-documentation event.* [...] *Circumstantial evidence is very different from factual "evidence." If one can give an explanation, then they have a strong argument that is descriptive of a necessary relationship between something seen and some prior dynamic process. That is circumstantial evidence of the best form. It's not a different phenomenon. It is simply an explanation carrying the most reliable details of causally relevant procedural information. The latter plays the role of the most powerful form of argument, because it provides the relevant information regarding causal linkages. As such, the process may be duplicated experimentally, and/or identified as having acted by patterned empirical phenomena derived from anticipated causal events and thus linked to observations indicative of secure causal sequencing."*

– Lewis R. Binford (2013: 9)

Abstract

This chapter analyses a number of case studies drawn from Anglophone lithic inquiry and examines whether research in this tradition can be grouped into 'formistic' and 'mechanistic' strands of investigation. The structural categories of the two respective world theories are brought to bear in order to demonstrate that this question can be answered in the affirmative. Four cases of 'formistic' and three cases of 'organicistic' research are identified and discussed in detail. Lithic 'formism' turns out to promote 'taxonomisation' and revolves around the analysis of patterns and associations of 'particulars,' 'characters,' and 'ties.' It is shown what hypothesis-testing in 'formism' amounts to and that 'subsistent' categories are often crucial in lithic explanations. Anglophone lithic 'mechanism,' by contrast, revolves around the 'specifity of response' principle and seeks to explain in terms of causality and other forces of directed determination. It tends to rely on 'prediction' and typically involves negotiating the 'observable'-'unobservable' boundary. Pepper's epistemology thus helps clarifying its cognitive status of the French-Anglophone divide and provides new insights into the internal structure and dynamics of the lithic analysis it hosts. The chapter substantiates the view that Anglophone lithic inquiry propagates a 'part-centred' approach to the available evidence.

The foregoing chapters have demonstrated that any approach to lithic evidence relies on pre-casting the world into a world hypothesis. It was shown that Anglophone researchers tend to deploy a particular type of such unrestricted world theories – theories which we have termed 'analytic' because they prioritise parts. The goal of the present chapter is to further explore this 'analytic' orientation and to examine its internal variability. Can lithic inquiry in the Anglophone world be broken down into 'formistic' and 'mechanistic' strands of reasoning? And if so, does this help us in understanding the logic of the Anglophone discourse – why scholars disagree, what they disagree on, and how? Responding to these questions requires the application of Pepper's structural categories to particular instances of lithic practice. To put it differently: it requires an *empirical* evaluation of the utility of the specific structural categories of the two world theories for illuminating the activity of Anglophone scholars.

The following two sections are designed to complete this task. I present a number of individual case studies and smaller fields of discussion which I take to be paradigmatic for Anglophone lithic research in Palaeolithic archaeology and analyse them in terms of Pepper's epistemology (see **Appendix III.4** for an explanation of the underlying rationale of case study selection and design). I will begin with illustrating the 'formistic' aspects of the Anglophone research enterprise by drawing on four different case studies. These are then complemented by an examination of three instructive cases of 'mechanistic' reasoning. The aim is to show that these examples substantiate the relative *unity* of Anglophone approaches insofar as all of them are committed to 'analytic' premises, yet they also clarify counteracting forces and sources of internal diversity that characterise the larger Anglophone research endeavour in lithic analysis.

If the application of Pepper's categories of 'formism' and 'mechanism' to these case studies turns out to be successful, this would drive home the claim that 'Anglophone' circumscribes a meaningful category in lithic research. Different schools, approaches, and more subtle research orientations *within* this Anglophone sphere of inquiry could then profitably be re-described as varying interpretations of two conflicting modes of reasoning – 'formism' and 'mechanism' – which nonetheless share a common 'analytic' conviction.

4.1 **Tropes of formism in Anglophone practice**

4.1.1 ***Scerri et al.'s multivariate approach to population structure***

Scerri et al.'s *Unexpected technological heterogeneity in northern Arabia indicates complex Late Pleistocene demography at the gateway to Asia* (2014) provides a recent glimpse into formistic aspects of reasoning in Anglophone lithic research. The principal objective of this paper is to test scenarios of dispersal and population dynamics at the gateway between Asia and Arabia during MIS 5. These scenarios are constructed as 'hypotheses,' but the latter are not derived from general high-level theory or model-based specifications of causal-determinative factors that may have produced the relevant empirical signatures under varying conditions. Instead, the respective hypotheses reflect the nature of the ongoing discourse on the role of peopling and population structure in shaping lithic technology. They remain rather general and are formulated in terms of *similarity* expectations (*ibid.*: 138). In order to test the status of their Saudi Arabian lithic material from the Jubbah basin, the authors compare metric and attribute data with the evidence from other sites in southern Arabia and the Levant. In terms of potential dispersals and population structuring effects, the guiding assumption is that dispersal should produce inter-site signatures of similarity, whereas population dynamics, depending on their nature, would either produce mixed signatures or reinforce dissimilarity among lithic assemblages. This logic is made explicit in Table 1, which specifies what the authors term "model expectations" (cf. *ibid.*: 128, 139).

While Scerri et al.'s (2014) approach is thus clearly hypothesis-driven and develops the respective test-implications before any lithic evidence is examined, a hypothesis is corroborated simply by demonstrating its *structural conformity* with the revealed data-signature. The authors, in other words, seek to establish a general *correspondence* between a hypothesis and the evidence thought to confirm it. The strategy is thereby not to eliminate all but one of the invoked scenarios, but rather to compare the results of data-analysis with the implications of the different scenarios in order to assess which conforms the most to the encountered lithic patterns. This mode of bringing formal hypotheses to bear is clearly formistic and relies on the 'correspondence theory' of cognitive criticism.[364]

The regulative idea is to certify that there exists a relationship of *form* between at least one hypothesis and the investigated set of lithic data – i.e., that the type of similarity that is entailed in the hypothesis is also encountered in the data:

[364] See Chapter 2; cf. Pepper (1942: 180-185).

> "The theory of truth which grows out of the formistic categories is the correspondence theory. Truth consists in a similarity or correspondence between two or more things one of which is said to be true of the others. In the extreme, truth might be ascribed to any one of a lot of similar concrete objects, as when we say of apple taken out of a box that it is a true sample of the whole lot. But ordinarily the term is reserved for such objects as pictures, maps, diagrams, sentences, formulas, and mental images. These are all concrete existents and the objects they are said to be true of are not exactly similar to them, but only in respect to the form under consideration or in accordance to certain conventions." (Pepper 1942: 180)

Since the relationship between hypothesis-construction and data-analysis is fairly 'loose' – neither do the model expectations specify which variables to select for analysis, nor do they enable a categorical discrimination between relevant and irrelevant lithic information – the approach to the data is largely unconstrained. Scerri et al. (2014) collect as much comparable lithic data as possible and analyse this data in multidimensional space.[365] The strategy is clearly 'dispersive.' All available lithic facts are picked up *as they are* and included in the analysis, the only exception being statistically non-comparable data (*ibid.*: 127). The aim is not to monitor the specific interactions between a limited number of variables, but rather to map out the general patterns of *association*, *correlation*, and *co-variation* that exists between different variables.[366] The looked-for similarities and differences between the studied assemblages are described in terms of the *participation* of 'particulars,' 'characters,' and 'ties' – expressed in artefact types, attributes, metric values, and ratios (cf. *ibid*: Supplementary Online Material [SOM]Table S1-S6) – in the data-patterns they create (*ibid.*: Fig. 2-8).[367] Thus, the analysis is mainly oriented towards exploring the *structure* of the different data sets – what the authors (*ibid.*: 129) describe as the "orthogonal dimensions of variability in the data" – and the relative overlap between these sets. *Unexpected technological heterogeneity* represents a maximally broad, 'part-centred,' 'bottom-up,' and largely 'inductive' study of lithic inter-assemblage affinities. This analytical focus on aspects of 'pattern participation' and the implicit reliance on 'set theory' to arrange patterns in multivariate space are consistent with the hallmarks of formism.

The authors generally note:

> "Within this broad approach, we also recognise that in order to avoid the pitfalls of intentionality and the construction of abstract schemas, it is desirable to have a priori reasons for choosing particular units of study, such as particular attributes (Tostevin, 2012)." (Scerri et al. (2014: SOM, 6)

They further assert that

> "[e]ach test and accompanying variables used in our analyses reflects related and interdependent knapping actions that can be compared between themselves. Some of these clusters are recognised to be affected by one or more processes (see Tostevin, 2012 for discussion). In this way our methodology permits the comparison of comparable stages in the chaîne opératoire of blank and core classes to achieve a whole structure of similarity and difference. By using multivariate statistics to isolate different, uncorrelated sources of variability driving the diversity seen in these classes of objects and their domains of manufacture, we can robustly assess whether learned behaviours may be isolated in analysis." (*idem*)

and argue

> "[…] that repeated patterns of similarity observed between the different classes of objects studied in this way (i.e., cores and flakes) is therefore a meaningful measure of similarity and difference in comparisons of the type presented in this paper." (*idem*)

---

[365] Although Scerri et al. (2014: Supplementary Online Material [SOM], 2-6) discuss some theoretical aspects of lithic technology, their main concern is to justify the broad approach to the lithic data they have adopted and to employ common and approved recording schemes. The goal of the discussion is not to narrow down the set of relevant data points.

[366] Scerri et al. (2014: SOM, 3) explicitly note that this approach allows them "to understand the relationships between several variables simultaneously by accounting for their effects on each other."

[367] For the centrality of pattern-recognition in archaeological research, see also Shennan (1997 [1988]: 3): "[…] inasmuch as all interpretation of the archaeological record is concerned with identifying patterning, it is capable of benefiting from a quantitative approach. The point that, within certain constraints, we are *identifying* patterning rather than creating it is an important one to which we will return later. Without such an assumption archaeological evidence would not tell us anything, but one of the virtues of the quantitative approach is that it can tell us in particular cases what a lack of pattern actually looks like." (original emphasis)

These statements confirm that *Unexpected technological heterogeneity* is committed to 'analytic' principles and seeks to identify the interaction of as many lithic variables as possible, some of which represent predefined 'classes' of objects. The value of each data point which can reasonably be recorded is *a priori* identical. The various multivariate analyses performed to determine the degree of association between different variables exemplify this situation.[368] All included variables, independently of their kind, are treated as if they are equally informative. This proclivity to equalise or normalise the evidence is also reflected in the transformation of continuous variables (i.e., metric data) into discrete categories by algorithmic clustering techniques. The latter is for example required when the kind of input data precludes 'principal component analysis' (PCA) and instead requires a 'correspondence analysis' approach (cf. Scerri et al. 2014: 134). Algorithmic transformation represents a classic formistic manoeuvre of data-driven classification.[369] Continuous variables are assigned a discrete value by analysing the overall structure of these variables and statistically determining inter-variable groupings. In other words, continuous variables are examined in terms of the patterns created by their values. This operation clearly relies on the 'Theory of Types'[370] – even if the resulting types are of course *probabilistic* entities.

Whether different assemblages host 'similar' or 'different' constellations of variables is established by measuring the relative *distance* between individual variables or the resulting clusters of variables in multivariate space. The important aspect of this multivariate approach is that it enables "*ordination* – the representation of relationships between items and between variables in a space of a small number of dimensions which still retain most of the information in the original descriptive variables" (Shennan 1997 [1988]: 265, original emphasis). The assessment of assemblage similarity is 'objective' in this sense – it directly *results* from the characteristics of the mapped out lithic parts.[371] Different clusters of variables – the patterns created by the recorded trait-sets of different lithic assemblages – can then be statistically compared in terms of their relative constellational affinity (Scerri et al. 2014: 130-138).[372]

The fact that Scerri et al. (2014: Figs. 6, 7) employ 'correspondence analytical' techniques is particularly informative. The virtue of such an approach, as Shennan (1997 [1988]: 308) clearly points out, is that 'multiple sets of object-values can directly be compared without the intervening information-losing step of creating similarities/distances.' The statistical description of these relationships results in the identification of *norms* in the data structure which can rigorously be compared. This screening of part-constellations for 'regularities' and 'norms' and their subsequent juxtaposition with other higher-order patterns is typically formistic. The variability in the encountered data-set is regarded to point to a certain 'ideal' regulating this variability. How patterned 'regularities' and 'norms' are realised is a question of varying 'principles of exemplification.'[373] The conducted correspondence analysis, for example to isolate patterns in core exploitation variables or the techno-morphology of Levallois flakes, reveals that the lithic data is analysed in terms of its *similarity* implications. This concerns the similarity of correlated variables, but also the similarity of their overall variability (cf. e.g. *ibid.*: 137f.). *Unexpected technological heterogeneity* is therefore clearly powered by the formistic root metaphor.

But how do the authors interpret the various similarities and differences they have unearthed? They conclude that their analyses

---

368 For a discussion of the principles and ramifications of multivariate analysis, especially 'principal component analysis' and 'correspondence analysis,' see Shennan (1997 [1988]: 265-360). Cf. also Olsen and Morgan (2005) for a general epistemological defence of multivariate analytical statistics.
369 Cf. Shennan (1997 [1988]: 216-264) and Rapkin and Luke (1993).
370 See Chapter 2; cf. Pepper (1942: 165-162).
371 Scerri et al. (2014: 126) stress that "[…] multivariate analyses allow to quantify the relationship between constellations of features including the presence of various methods and concepts without giving typological bias to named industries or techniques."
372 The use of unconstrained multivariate techniques marks a potential point of divergence between 'formistic' and 'mechanistic' lithic analysis. The unconstrained exploration of multivariate interaction is typically viewed with extreme suspicion by 'mechanists.' They typically complain that such a mode of marshalling the evidence clouds the view for what is actually important in terms of data and interactions, and thus 'prevents us from seeing the wood for the trees.' McPherron's (1994) instructive discussion on advantages and disadvantages of multivariate statistical procedures is a point in case. McPherron (*ibid.*: 54f) provides arguments for why multivariate statistics tend to be inferior to narrower, but theoretically pre-informed approaches such as 'linear regression.' The main point is that most multivariate techniques are too 'dispersive' for the 'mechanist' and she/he would therefore typically favour more 'integrative' statistical approaches.
373 See Chapter 2: esp. **Box 6** for definitions of the 'formistic' concepts.

> "[…] find significant technological overlap between northern Arabia and northeast Africa in particular, which may indicate either evidence for modern human dispersal or cultural diffusion between dispersing modern humans and existing archaic populations in northern Arabia. While a dedicated comparison of these assemblages with Levantine assemblages […] may provide greater clarification, we suggest that the structure of the observed similarities shows that demographic complexity was already a key feature of populations at the gateway to Eurasia" (Scerri et al. 2014: 140).

Together with the earlier statement of the authors that

> "[t]he premise underlying such a comparison is that technological similarities, particularly where recurring through several domains of analysis, can be hypothesised to represent shared population histories" (*ibid.*: 126).

this clearly suggests that they infer an intimate relationship between technological expressions and the history and structure of populations in the respective regions. They argue that the evident complexity of these technological expressions likely indicates that the corresponding population-level processes were equally complex (*ibid.*: 140). This is then interpreted as additional evidence for the fact that human populations indeed moved in and out of Africa in a much more frequent and multidirectional manner than previously assumed. They further suggest that their results support the idea that Arabia was a key region of human dispersal and are consistent with the emerging recognition of the complexity of modern human biology at the time – a thoroughly 'correlationist' take on the evidence.[374]

The first aspect to note is that a complex data-pattern is thought to reflect a complex underlying process. This drives home the point previously made, that some form of *structural congruence* between evidence and explanation is assumed. The second point is that the process producing the pattern is thought to be of a different nature than the pattern itself. Stones, in other words, cannot be explained by stones themselves, but always refer back to their human producers. Since Scerri et al. (2014) examine 'populations of stones,' the idea seems to be that the delineated 'patterns,' 'norms,' and 'regularities' tell us something about 'populations of people.'[375] This suggest that there is a basic structural *co-variation* between human demography and technological expressions. Instead of framing this relationship in causal-determinative terms, it is described fairly generically – the link between lithic technology and the structure of human populations is regarded to be of a *general* kind. This 'looseness' of the explanatory relationship reflects the formistic conception of the world as a weakly determined place.[376] With Pepper (1942: 168-170, 177), we can add that *demographic processes* thereby come into view as 'subsistent' factors. They themselves do not participate in the observed patterns but are identifiable as sets of not fully particularised 'complex characters.'[377] The 'subsistent' category of demography is distinguished from the categories of 'existence' – i.e., the lithic variables – and thereby satisfies the formistic intuition that *matter* takes specific *forms* because it exemplifies particular *norms*.[378] Matter, in other words, takes these forms because of factors not related to matter. This general configuration of reasoning clearly demonstrates that *Unexpected technological heterogeneity* embodies a formistic approach to the lithic evidence. The analysis of the African and Arabian Middle Palaeolithic

[374] For a similar interpretive ambition, see for example Scerri et al. (2018).
[375] This amounts to a Neo-Platonic manoeuvre. Just like Plato identified the 'phenomenal' world as a collection of shadows whose creators are not directly graspable, Scerri et al. (2014) consider lithic evidence as a proxy for human populations which are not directly observable. Lithic data is essentially viewed as the 'shadow thrown by intangible populations.' Obviously, this interpretation involves aspects of transcendental reasoning, since it depends on the general assumption that the *conditions for the possibility* of lithic artefacts include human presence and production. 'Formistic' patterns of reasoning are therefore often masked as generic inferences by *abduction*. [Abduction is typically defined as inference to the best or most self-evident explanation (cf. Putnam 1981; Poston and McCain 2017).] In general, the compositional structure of the observed phenomena is explained by a different entity which, in some relevant sense, can be said to have existed prior to the phenomena in question, and to lie beyond the 'horizon of sensation.'
[376] See Chapter 2.
[377] See Chapter2: **Box 6**.
[378] Because of the generally open pool of potential 'subsistent' candidates, 'formistic' reasoning typically relies on excluding other such potentially relevant candidates. This elimination or rejection of competing 'subsistent' categories is thereby also a 'formistic' strategy to deal with the problem of *equifinality* – in 'formism,' the problem that similar patterns may point to different 'subsistent' categories or that similar forms may participate in different 'laws,' 'regularities,' or 'norms.' Scerri et al. (2014: 128), for instance, not only try to hold constant the eco-zone from which their study material derives (Saharo-Arabian subtropical grassland and shrubland biomes), but also make sure that their sites have been selected according to river, lake, or raw material adjacency. Furthermore, they make some specific arguments in order to reject the possibility that simple reduction effects may account for their observations (*ibid.*: 129-131).

data is motivated by a correspondence conception of truth and explained by first exposing the structures of 'existence' and then putting them into perspective by invoking a particular category of 'subsistence.'

4.1.2 ***Conard et. al.'s core reduction taxonomy***

The second example of the formistic orientation of Anglophone lithic research is *A Unified Lithic Taxonomy Based on Patterns of Core Reduction* by Conard et al. (2004). This short paper tackles the issue of core classification in a manner characteristic of formism. The authors present a generalised taxonomy for organising the variability of cores encountered at Palaeolithic sites from Africa. While the paper is not so much concerned with the application of the proposed classification, the authors regard their 'taxonomic work' as an indispensible prerequisite for engaging with more specific lithic research questions and to facilitate scholarly communication both within the community of lithic Africanists and African and European approaches. Accordingly, the chief objective of *A Unified Lithic Taxonomy* is described as

> "[...] defining a taxonomic system for chipped stone artefacts that can be applied to materials from the Early, Middle and Later Stone Age. The motivation for defining a 'unified taxonomy' stems from the need to develop a system for classifying multi-component surface assemblages. The proposed taxonomy revises southern African systems by applying ideas and methods from European approaches to lithic technology. Given that much confusion exists on the classification of cores and core reduction, the lithic workshops focused on this class of artefact." (Conard et al. 2004: 13)

Based on the examination of the lithic material from a range of especially Southern African sites, Conard et al. (2004: 14) suggest that the most part of the observed variability of cores can be satisfactorily captured by three "main taxa," encapsulating 'Inclined,' 'Parallel,' and 'Platform' core-types (**Fig. 11**). These are complemented, if necessary, by core categories termed 'Initial,' 'Multidirectional,' 'Intermediate Broken,' 'Bipolar,' and 'Other' (*ibid.*: 15). Cores are defined as 'objects from which potentially useful flakes have been removed' and following Deacon (1982) must exhibit at least three deliberate removal scars (*ibid.*: 14). Individual cores are then classified based on well-defined sets of shared characteristics. These include the number of preserved flake negatives, the number of adjacent removal surfaces, angle(s) of flake detachment, aspects of general morphology (i.e., 'conical,' 'biconical,' 'asymmetric cross-section,' 'polyhedral,' etc.), the direction of preserved removals, the presence and location of core preparation, and the number of striking platforms (*ibid.*: 15f.). The overall constellation of these characteristics, with a particular emphasis on core morphologies and the organisation of removals on the exploitation surfaces, determines the taxonomic group into which an individual piece is placed (cf. *ibid.*: Table 1).

The logic of classification is 'atemporal' and revolves around the identification of *necessary and sufficient conditions* for grouping artefacts.[379] It is atemporal because the archaeological context including the dating of the artefacts but also the particular attitudes and research interests of the examiners do not matter. The goal is to devise effective core categories that can be used to describe core variability of "all ages" (Conard et al. 2004: 14). The unit of classification is the self-sufficient 'atomised' piece. Each single core is analysed in terms of its individual features and then compared to the list of characteristics tied to each taxonomic grouping. An artefact is assigned to a specific core taxon only if it fulfils all of the listed necessary conditions. Classificatory practice therefore follows a clear 'if-then' logic determining which core is ascribed to which group of objects under which conditions. The authors themselves repeatedly emphasise that they aim to provide a system of organising lithic evidence that is 'unambiguous' and easily 'reproducible' by different lithic workers. The independent evaluation of the reliability of the devised categories by a series of blind tests illustrates this point (*ibid.*: 16). These analytical standards, of course, ought to apply to individual objects, not to assemblages or other object totalities.

The authors explicitly point out that

[379] The search for necessary and sufficient conditions can be a 'tool,' 'heuristic,' or 'regulative idea' to help specify the application of a definition or concept under scrutiny (cf. e.g., Brennan 2017).

> "[…] the taxa described below represent a high-level classification and that within the main groups of Inclined, Parallel and Platform many subclasses exist and can be recognized using the key variables discussed at the end of the paper." (Conard et al. 2004: 15)

According to Conard et al. (2004: 16f.), these additional key variables comprise the morphology of the core endproducts, the degree of reduction between initialised and exhausted cores, the degree of utilising core circumferences, frequency of striking platform and removal surfaces expressed in numerical values (i.e., integer data), and the degree of platform preparation reflected in both cores and *débitage*.[380] The result is the ability to discriminate between different *degrees* of inter-core similarity. The higher-order taxonomic groupings provide more general descriptions of core types entailing a range of lower-order, more specific groupings, such as Levallois cores (*ibid*.: 16). This illustrates that different 'classes' of cores, established based on varying granularities of resemblance, can be *ranked* within a larger system of classification.[381] This system, in turn, reveals the natural *hierarchy of facts*.[382] In other words, those characteristics which define the higher-order groupings are considered to be more important in understanding core reduction technology than those discriminating the lower-order classes.[383] The hierarchy of object groupings also tells us whether a grouping is relevant on a general level of inquiry or whether it is more likely to be effective in specialised research contexts. The higher-order core categories – the 'taxa' in the words of Conard et al. (2004) – are thought to have this *general* bearing, whereas the finer-grained categories – what the authors call 'subclasses' – should help addressing more specific issues and questions in lithic research. This logic is distinctively formistic. Not only are differences in lithic parts – objects, traits, attributes and relationships between the latter two – systematised according to Pepper's 'Theory of Types,' the explicit goal of *A Unified Lithic Taxonomy* is the creation of a *universal classification*, ordering the lithic facts from the more general to the less general.[384] A 'class,' in this view, is nothing less than "a collection of particulars which participate in one or more characters" (Pepper 1942: 159). The point is that these classes are regarded to reveal something substantial about the *structure* of lithic reality, as well as about the particular 'norms' that must have guided the transformation of 'matter' into recognisable lithic 'forms.' More generally speaking, the interpretation of *lithic typology as taxonomy*, in particular if the latter is viewed as an independent domain of scholarly activity, is a highly diagnostic condiment of formistic reasoning.

A few remarks on the epistemology of 'taxonomic reasoning' may be useful here. Taxonomies seek to portray patterned regularities in observable reality; they capture how reality is compositionally organised, that is, how one can dismember it into parts. Taxonomies thereby identify and define the entities that can be said to populate this reality on various levels of existence – they respond to the intuition that 'unless reality contains some order, we can find no order in it' (Grene 1990: 239). The first aspect to note is that 'taxonomisation' is thus typically an 'analytic' operation. The second aspect is that many different classifications are always possible and taxonomies thus depend on some form of *external* significance. Many taxonomies, for instance, seek to delineate classes that figure in laws or facilitate the formation of such laws (cf. Hull 1998; Honenberger 2015: 28). Some authorities would

---

[380] Two aspects are remarkable here. First of all, some of these variables have already been covered, at least partially or in a slightly different format, by the initial list of core classification (cf. Conard et al. 2004: Table 1, 15f.). The specified additional variables meant to create sub-classes therefore feel redundant at times. Secondly, although the proposed classificatory scheme focuses exclusively on cores (*ibid*.: 13), the authors now suddenly introduce non-core features. This invocation of endproducts and *débitage* preparation is surprising at best. The authors, for instance, leave it completely open how the corresponding *débitage* pieces can reliably be identified. These difficulties almost certainly generate some interpretive problems.

[381] The prototype of a ranked system of classification is the nested hierarchy of nature encapsulated in Linneus' *Systema Naturae*. This classificatory system discriminates between 'family,' 'order,' 'genus,' and 'species' (see also Simpson 1961; Schuh 2000). The general idea in lithic studies has always been to come up with an analogous way of classifying lithic objects and to learn something from it about the general organisation of human stone technology.

[382] The distinction between the three 'main taxa' of cores and five complementary taxa as well as the differential interpretive treatment of the groups suggests that the former are regarded to embody a degree of "truth" or "certainty" that the latter are lacking. It indeed appears as if the complementary taxa represent "half-truths," a genuine category of 'formism' (see Chapter 2).

[383] This 'hierarchy of facts' may be interpreted as specific way of theorising the classic 'formistic' distinction between *essential* and *accidental* properties (cf. Robertson and Atkins 2018). An essential property is a property that an entity, typically an object, must have. Accidental properties, by contrast, are properties that entities happen to have but could lack. Classifications can be interpreted to reveal the grading between these categories of properties: the more general the class, the more likely is it to delineate essential properties. This is why more general classes are sometimes said to be more 'real.' This way of using classifications entails some form of 'essentialism.'

[384] See Chapter 2: esp. **Box 6**; for the role of *classification* as a primary analytical operation in 'formism,' see Pepper (1942: 159-161).

indeed argue that 'true' classes are distinguished precisely by their participation in these laws. This conception not only reflects the formistic understanding of laws as 'strong norms which regulate occurrences in nature and render them regular' (cf. Pepper 1942: 166),[385] it may also result in the identification of classes as *natural kinds*.[386] 'Natural kinds' are groupings that echo the *natural structure* of the world (e.g., Bird and Tobin 2018). Classification, conversely, supplies a tool to detect such 'natural kinds.' Yet, the fact that different classifications compete for knowledge and that classification itself usually fails to provide the ultimate means to reach out to the genuine structure of reality can be taken as evidence for the formistic idea that reality is only weakly ordered. The same formistic belief in the lack of 'integrative determination' motivates a strong reliance on classification in the first place. The creation of taxonomic systems is typically a reflex of 'dispersive' modes of handling evidence, in which the primary emphasis lies on the *proliferation* of fact and the *incorporation* of as many disparate facts as possible.

A number of observations suggest that Conard et al.'s (2004) grasp of classification and its role in lithic studies is in accordance with this general characterisation of 'taxonomic reasoning.' The authors for example note:

> "Here it is worth reiterating Brew's (1946) observations that there are no perfect or ideal taxonomies in archaeological systems, and that the field has more often suffered from having too few rather than too many taxonomies. As new knowledge accumulates and new problems are defined, new taxonomies will be needed. While all new systems should be viewed with a healthy dose of scepticism, one should not resist attempts to develop new approaches. Taxonomic systems that do not prove to be useful can and should be discarded. Conversely, to a certain extent, the existence of multiple mutually intelligible systems presents no significant problems to researchers and can enrich archaeological discourse." (*ibid.*: 13f.)

They also emphasise that

> "[c]lassifying lithic artefacts does not constitute an end in itself; it should be seen as one step in the overall analysis of lithic artefacts in relation to patterns of human behaviour." (*ibid.*: 13)

and add:

> "It should, however, be stressed that cores change as they are reduced so that it is possible for cores to reflect different patterns of reduction at different stages of knapping. [...] Equally important is the observation that there is continuous variation between the three main patterns of reduction." (*ibid.*: 15)

These enunciations make clear that the authors regard 'taxonomisation' as important coordinate of scientific progress in the field. They similarly indicate that the interpretation of taxonomic groupings depends on the kind of background theory adopted.[387] This last point is evident when one reads the individual descriptions of the different core taxa, in which recurrent reference is made to 'stages of knapping' and a 'continuous process of lithic reduction' (cf. *ibid.*: 15f.).[388] Already the description of the taxa includes interpretive suggestions what these might mean in terms of reduction dynamics and a continuous space between 'early' and 'late' reduction stages. The taxon 'Initial' is for example identified as likely reflecting earlier stages of lithic knapping (*ibid.*: 15). The generally continuous character of lithic reduction also regarded to explain some of the observed borderline variation. The authors explicitly state that we should "not be surprised that some cores are difficult to classify because they fall within the 'grey zone' between the main types" (*idem*). Individual cores may either deviate from

[385] Cf. Chapter 2: **Box 6**.
[386] Hull (1969: 169f.) for example notes: "[t]raditionally the notion of type entails that membership in a natural kind is determined by one set of characters which are severally necessary and jointly sufficient."
[387] Although Conard et al. (2004) admit the theory-ladenness of scientific classification (cf. Schurz 2011: 63), they determine the key classificatory variables on the basis of the structure of their evidence. Theory, therefore, plays only some vague and rather *post hoc* role in their taxonomic approach. Clearly, the primary emphasis of the authors lies on *phonetic* classification, that is, classification based on the resemblance of traits. Following Schurz (2011: 66-70, Abb. 2.11), *phonetic* classification can be distinguished from *phylogenetic* classification which may either take the form of *cladistics* (after Henning) or *evolutionary* systematics (after Mayr). The latter are methods of 'top-down' classification. Note that although 'formists' generally tap into the full spectrum of classificatory means, the more 'functional' taxonomies are typically also accepted by 'mechanists,' especially if classification reflects their principles of causality and 'primary laws.'
[388] Needless to say, the tacit adherence to a 'continuum' conception of lithic reduction is highly significant, but it is not the main concern of the present analysis. We will return to this issue in the second part of the present chapter, when various incarnations of Anglophone lithic 'mechanism' are scrutinised.

the reduction pattern they *normally* embody or they may represent in-between reduction stages. This insistence on the 'normality' of pattern and the idea that individual core taxa represent 'norms' of lithic knapping which are materialised by particular 'principles of exemplification' (i.e., methods of reduction) is a classic formistic figure of interpretation.

Because such 'norms' of lithic reduction are inferred on the basis of 'complex sets of characters,' a norm itself is rarely fully particularised and thus typically transcends its complete materialisation.[389] The author's assertion that their lithic core taxonomy somehow resonates with different 'methods of reduction' (*ibid*.: 14, 16) is only intelligible if we accept this interpretation of reality and identify the *behaviour of reducing cores in various ways* as the 'subsistent' category of their analysis. The idea would be pretty simple: if there are different knapping plans or norms of reduction, these would result in a differential treatment of 'matter' which, in turn, would result in varying lithic 'forms' – that is, varying constellations of the physical characteristics of cores. 'Methods of reduction' are exemplified by particular part-configurations but resist complete materialisation – they "subside" as Pepper (1942: 177) would say. Whether the 'method of reduction' throwing its material shadow into the world of 'existence' is thereby conceptualised strictly as a 'technical norm' or a 'technical law' in the formistic sense of these notions does not matter much. The key point is that the correlation between 'methods of reduction' and 'complex lithic patterns' is effectuated by the distinction between a directly observable domain of lithic objects and a veiled realm of 'subsistence.'[390] The latter supplies the conditions for the possibility of encountering particular patterns in 'concrete' reality and must therefore 'exist' in some sense itself. Conard et al.'s (2004) 'methods of reduction' therefore assume an almost Platonic status – as *abstract entities* with concrete material correlates.

A Unified Lithic Taxonomy generally occupies similar epistemological ground as Monnier (2009: 122), who has recently given a strong voice to the formistic argument that there can be no lithic knowledge without explicit classification:[391]

> "I submit that we cannot, in fact, escape typology. Regardless of one's ultimate goal, artifacts still need to be organized in some way before they can be analyzed. The search for technological patterns cannot begin until lithic artifacts are organized into coherent categories based on technological attributes and features. The creation of a typology of technological attributes should be done carefully and should be informed by the science of classification (e.g., Adams and Adams 1991). Most of all, this typology should avoid confounding description with interpretation. [...] In conclusion, although many would agree that the ability of Bordian typology to inform us about human behavior in the Middle Paleolithic is limited, *typology* itself is not a "bad approach." It is a necessary tool of archaeology because our first task is to organize the artifacts we are studying. We must simply do it explicitly and carefully." (original emphasis)

The importance of this formistic argument for the indispensability of the 'Theory of Types,' classification, nomenclature, and taxonomy can hardly be overrated. The issue of "typological reasoning" – to use the words of famed biologist Ernst Mayr (1976 [1959]: 27f.) – has divided 'mechanistic' and formistic camps of scholarship ever since. This division is for instance expressed in the authorative 'Grene-Hull debates' on the status of typology and the concept of species in evolutionary biology (cf. Honenberger 2015). While David Hull (1965a, 1965b, 1976, 1989 [1986]) joined the ranks of Mayr and others arguing that typological reasoning and hollow taxonomies represent relics of a pre-Darwinian and essentially 'non-scientific' era of research (cf. Winsor 2006), Marjorie Grene (1958, 1974, 1989, 1990, 2002), by drawing on a solid Aristotelian foundation, defended the obligatory status of 'typologisation' and 'taxonomisation' in understanding both nature and evolution. Grene (1990) in particular argued that the kind of 'population thinking' propagated by Mayr, Simpson, and other architects of the 'New Evolutionary Synthesis' inevitably leads to self-contradiction – to all kinds of logical absurdities – and is thus untenable;[392] she also stressed the need to take serious the observable *structure* of reality which, according to her, is typically explained away by Neo-Darwinian approaches (cf. Grene 1958:

[389] Cf. Chapter 2: **Box 6**.
[390] 'Mechanists' are typically sceptical about this form of pattern-explanation mirroring. They tend to insist on the 'specifity of response' principle and argue that explanations need to remove any vagueness in the relationship between the *explanandum* and the *explanans*. An explanation, in other words, cannot only be adequate by its form, that is, structural congruence between observed patterns and more abstract concepts driving these patterns.
[391] See also Clarke's (1968: Chapter 12) invocation of 'numerical taxonomy' as an early, yet influential expression of taxonomic reasoning in Anglophone archaeology.
[392] For the role of the debate on 'essentialism' and 'typological thinking' on the development of the 'New Evolutionary Synthesis,' see Chung (2003), Amudson (2005), and Winsor (2006).

125-127). The debate is thus a classic instance of the clash between formistic and mechanistic standpoints. The formistic view highlights the need to pay heed to the organisation of facts in both their phenomenal horizontality and verticality and assumes that the distinct kinds identifiable in this way refer back to the 'subsistent' qualities responsible for their 'existence.' The mechanistic view, by contrast, insists on a more specific, necessity-governed link between the observable and the unobservable and tends to conceptualise the matrix of causality as a 'field structure' (cf. Chapter 2). Within this 'field structure' of reality, all residual discreteness must be resolved because any remaining discreteness would ultimately undermine the singularity of cause-and-effect.[393] Arguably, the discussion in Palaeolithic archaeology can be reconstructed along similar lines. The supposed formistic 'essentialisation' of reality, for instance, is regularly criticised by more mechanistically-inclined researchers (e.g., Shea 2011b).[394] We will recurrently come back to this issue in the course of the present chapter.[395]

A brief look into the latest work of the first author of *A Unified Lithic Taxonomy* further reassures us that formism, for the most part at least, provides the relevant cognitive framing in this context. In a paper on behavioural variation and change throughout the Middle Stone Age sequence of Sibudu cave (South Africa), for instance, Conard and Will (2015) identify patterned regularities and trends in lithic technology based on an explicit 'attribute analytical' approach. Their measure to establish 'regularity' and 'focused' patterns of change is *statistical similarity*. They directly link the emerging patterns in the lithic data to 'patterns of behaviour.' Again, the idea is that the lithic evidence reflects back to hominin behaviour in rather generic, yet nonetheless intimate ways. Hominin behaviour and lithic patterning, in other words, are thought to substantially *co-vary*.[396]

Similarly, the author's generalised and fairly abstract hypotheses (*ibid.*: Fig. 16) are evaluated in terms of the latter's *structural similarity* with the patterns observed in 'concrete' reality. The same tendency of structurally aligning empirical findings and advocated explanations results in the emphasis of the purported 'complexity' of the behavioural strategies under investigation. Thus, 'behaviour' clearly accounts for the 'subsistent' category of the study – a category that is illuminated by an extremely detailed examination of the lithic evidence, yet remains deprived of equally rich characterisations. Metaphorically speaking, this situation clearly attests to the formistic recognition that the details of 'subsistent' qualities typically remain 'hidden' and 'stored away' behind a wall of 'existence.'

Furthermore, the 'subsistent' category of behaviour, in classic 'correlationist' fashion, is ultimately secured by demonstrating that potentially competing 'subsistent' categories such as external environmental or ecological conditions are not significantly correlated with the lithic patterns in question and can thus faithfully be excluded as candidates of explanation.[397] The reasoning is thus as follows: if there is no evident external correlation, the relevant 'subsistent' category must be 'internal' – i.e., it must be a category intrinsically bound to the 'primary existence' of the lithic artefacts in question. This logic of research, overall, is undoubtedly formistic.

4.1.3 ***Morphometrics and cultural phylogeny***

A third window into Anglophone formistic thought is opened by the application of elaborate morphometric approaches to lithic artefacts (e.g., Lycett 2007a, 2009b, 2010, 2016; Iovita 2008, 2011; O'Brien 2010; Archer and Braun 2010; Eren and Lycett 2012; Lycett and Cramon-Taubadel 2013, 2015; Archer et al. 2016, 2017; Iovita et al. 2017).[398] 'Morphometrics' is commonly referred to as the quantitative study of *shape*, *morphology*, or *form*. In contrast to more traditional methods of describing these features in archaeology, morphometrics uses an array of statistical tools to determine object geometries, often using 'landmark' and 'semi-landmark' approaches (cf. Iovita 2008; Lycett 2009b; Eren and

[393] See also **Appendix II.2** for a discussion of this issue.
[394] Indeed, the entire 'human modernity' discourse can be reconstructed along these lines.
[395] To counter a potential scepticism of the attentive reader, it should already be noted that the present author argues that the French tradition has largely departed from its initial 'formistic' trajectory. Even though the 'Bordian era' (*sensu* Sackett 1991) was clearly build on 'formistic' reasoning, the 'technological revolution' co-initiated by Leroi-Gourhan and Tixier in Paris marks a definitive break with 'formistic' epistemologies. This will become clear when the role and status of lithic typologies in French technological inquiry is examined (cf. Chapter 5, first part).
[396] Cf. "Cultural taxonomy should not be regarded as a static tool, but as a way to qualify and quantify degrees of behavioural variation." (Conard and Porraz 2015: 129)
[397] Cf. Conard and Porraz (2015: 128).
[398] I use a relatively broad definition of morphometrics here to include the work by Stephen Lycett and others.

Lycett 2012: S1).[399] The main concern of these techniques is 'shape realism,' that is, the idea that object-shapes represent 'rich' and 'complex' phenomena which need to be measured and compared as what they are – as *morphological totalities*.[400] The general contention is that significant variation in the morphometric properties of lithic artefacts is easily overlooked when adhering to methods that tend to reduce the multidimensionality of shape-data to a limited set of variables or simply capture different kinds of shapes by distinct descriptive categories. These approaches are regarded as 'reductionist' by proponents of morphometric analysis. Morphometrics seeks to bring the 'three-dimensionality' of objects to the fore of lithic inquiry and to carve out data that takes the 'plasticity' of lithic forms seriously into account. The basis of morphometric approaches is provided by an explicitly 'analytic' understanding of 'geometry,' 'shape,' and 'size,' so that these vectors of object variability can be modelled and compared "with the precise language of mathematics" (Thompson 1961 [1917]: 269, cited by Lycett 2009b: 79; cf. Lycett and Cramon-Taubadel 2013: 1509):

> "'Morphometrics' is now seen as a major field of growth in biology and palaeontology, including physical anthropology (e.g., O'Higgins 2000). Put simply, morphometrics is the application of the principles of geometry to the study of shape. Others have pointed out that morphometrics may also usefully be termed 'statistical shape analysis' (e.g., Dryden and Mardia 1998)." (Lycett 2009: 79f.)

As Lestrel (2000: 59f.) correctly notes, the morphometric approach owes a great debt to Plato and Aristotle. First, it recognises the fundamental distinction between *matter* and *form*. Shaped matter assumes certain 'shapes,' 'sizes,' and 'morphologies' and has a particular 'structure.' Access to the *form* of an object is provided only by sense perception, but *form* always relates back to something non-sensory. The reason is that *form* presupposes the actualisation of altered matter and this, in turn, implies a shaper other than matter itself. Forms therefore throw a 'shadow' on non-spatiotemporal aspects of reality – aspects that cannot directly be observed and must be inferred. In formism, these aspects are identified as 'norms,' 'laws' or other patterned regularities. The crux, as we learned before, is that these are never fully materialised and can therefore only be *pointed at* – they 'subside' (cf. Pepper 1942: 177). That morphometric research often has to retain a notion of the 'ideal' in order to move 'beyond' the sensually given, can for example be seen in the fact that researchers typically isolate trends of 'normality,' calculate complex statistical averages, and utilise visualisation techniques such as 'group centroids' to compare different data-sets (cf. Lycett 2009b: esp. Figs. 1, 2). The entities that come into view in this way are not directly observable.

Morphometric research is guided by the conviction that a more careful, precise, and detailed analysis of artefact form puts researchers into a better position to interpret the significance of the variability of lithic form. What is thereby tacitly assumed, of course, is that *discrete form* is a basic facet of 'concrete' reality. Notwithstanding, morphometric results may for example be harnessed in order to re-investigate shape patterns among lithic artefacts and to re-address questions of co-variation between artefact geometry and other artefact-external variables. Another commonly used possibility is to rigorously explore the *structure* of lithic shape variability and to compare the results to the structure of other domains of reality. Since morphometric approaches tend to improve both the quality and quantity of geometric lithic data, they can supply novel typologies and other more specialised object classifications. All of this helps placing classic formistic reasoning onto firmer empirical grounds.

Gowlett (2010), for example, self-consciously embraces this new opportunity for lithic research:

> "New is often better, and the Morphometrics has many possibilities. For instance, its techniques allow the analysis of form free of size variation (effects), with particular benefits for archaeology's yearning to explore templates. Such an "ideal" form should not exist in biology, as natural selection is primarily undirected, but in cultural phenomena (and here we hark back to Plato's Ideals) the pressures towards norms can create the situation where everyone agrees about the same thing ("it should be just like this"). The implication is that we need to know a great deal more about stereotypes and templates, and how they operate in modern humans, to get even more out of these [...]." (*ibid.*: 310)

---

[399] The methodological and conceptual background of 'morphometrics' has been developed in biology and palaeontology (cf. O'Higgins 2000; Slice 2005, 2007; O'Higgins and Jones 2006). Even more specialised methods such as 'Fourier Analysis' derive from biological or physical anthropological applications (e.g., Lestrel 1997).

[400] This, of course, does not necessarily mean that a different type of data is used altogether. Neither does it mean that these approaches are 'synthetic.' What changes, however, is the *density* of geometric information that is used to analyse the form of objects.

Gowlett's statement is remarkable, for it explicitly contends that morphometric approaches cannot only facilitate the search for 'templates,' but also help isolating 'ideals' and 'norms' of hominin behaviour. He even evokes Plato's *ideas*. Needless to say, all of this attests to a deeply formistic mode of reasoning (cf. Chapter 2: esp. **Box 6**).

A specific way of putting morphometric approaches into perspective is by using their results to answer phylogenetic questions (e.g., Lipo et al. 2005; O'Brien et al. 2013; Lyman 2015). The recorded variability of lithic forms can be studied as the result of evolutionary processes producing non-random patterns of geometric development through time. Morphometrics, then, serves the explanatory goals of Darwinian evolutionary theory, which often changes the looked-for units of analysis (Lyman and O'Brien 2000) – typically 'populations of artefacts' that evolve over time (e.g., Shott 2011; Edinborough et al. 2015; Lycett 2016).[401] Lycett (2016: 83-88; cf. Lycett and Taubadel 2015), for instance, explicitly argues that inherited changes in behaviour, culture, and social transmission will affect how one *makes* tools and thus inevitably alter at least some dimensions of artefact form.[402] This is why changing patterns of form can be used to infer trajectories of hominin behaviour, culture, and possibly social transmission.[403] Form-based data of discrete lithic parts is used to reveal developmental patterns pointing towards the unobservable horizon that lies behind empirical reality. The important point is that although evolutionary mechanism that fulfil the 'specifity of response' requirement are often discussed, they are not strictly needed to explain the observed regularities since 'neutral variation,' 'drift' and other stochastic effects may be similarly invoked. In the extreme case, 'time' itself may be conjured as a sufficient 'subsistent' category.[404] This leads to 'historical' interpretations of morphometric change and reintroduces the dimension of *cultural history*.

Even though the majority of morphometric and phylogenetic studies to date has been conducted in New World research contexts (e.g., Buchanan et al. 2014), similar approaches become also increasingly popular in studying the Palaeolithic of the Old World. The work of Lycett (2007, 2009a, 2009b, 2010, 2016) and, more recently, Archer et al. (2016, 2017) exemplifies this emerging trend. Two of these papers – Lycett's (2009a) attempt to make use of phylogenetic analysis in order to track hominin dispersal in the Lower Palaeolithic on the one hand, and Archer et al.'s (2016) investigation of the regionality of point technology in the South African MSA on the other – will be analysed in more detail in the remainder of this section. As case studies, they will help throwing further light on the formistic conditions of lithic knowledge production in Anglophone lithic inquiry.

[401] These approaches are typically modelled on biological or cultural evolutionary theory. An expression of the former school of thought is *Darwinian Archaeology* seeking to understand artefact phylogenies by means of concepts and methods borrowed from biology and/or palaeontology (Dunnell 1989; Lyman and O'Brien 2000; cf. Donald and Maschner 1996). The second strand heavily draws from principles of cultural evolution in order to understand the patterns of the past (cf. Shennan 2009; Mesoudi 2016). Shennan's *Genes, Memes and Human History* (2002) is surely one of the founding texts of this second approach-type. In contrast to *Darwinian Archaeologies*, cultural evolutionary models emphasise role of social transmission as a general mechanism of evolutionary change. In practice, of course, biological and cultural evolution are often combined to provide an integrated perspective on the past (O'Brien and Lyman 2003; Shennan 2008; O'Brien and Shennan 2010). Mesoudi et al.'s (2006) plea for a unified science of cultural evolution still resonates with the agendas of many of these approaches (cf. Mesoudi 2011). More generally speaking, the important manoeuvre has been to re-define the concept of culture and to recast it as a patterned process of social transmission – a view that generally aligns with the proposals of 'Dual Inheritance Theory' (Boyd and Richerson 1985; Richerson and Boyd 2005).

[402] Cf. "[…] The key point here is that many quantitative traits of artifacts segregate across several different heritable causal factors, just as in the case of multifactorial quantitative traits examined in biology. Yet also, some aspects of attribute variability may result from the type of clay to which these socially learned factors are applied – in other words, the "environment" in which the inherited components operate may influence variability in observable attributes too […]. Hence, observable archaeological traits will invariably be influenced by multiple unobservable and "pleiotropically" operating cultural elements, while also simultaneously being influenced by "environmental" effects […]." (Lycett 2016: 80)

[403] There is a large body of theoretical literature on different types of social transmission that may have played a role in bringing forth different patterns of continuity and change. This general theory is sometimes called 'cultural transmission theory' (Eerkens and Lipo 2007). It is noteworthy that different *types* of social transmission are usually discriminated in order to enable correlational procedures. Different processes and mechanisms of transmission are also thought to have different observable consequences. Depending on the mode of mobilising this body of theory, approaches may develop into 'formistic' or 'mechanistic' strands of inquiry.

[404] Cf. Chapter 2: **Box 6**.

Lycett's phylogenetic approach to Acheulean dispersal

Lycett's *Understanding Ancient Hominin Dispersals Using Artefactual Data: A Phylogeographic Analysis of Acheulean Handaxes* (2009a) tests the 'African Acheulean Hypothesis,' that is, the idea that the presence of Acheulean handaxe technology in non-African contexts is the result of hominin dispersal out of Africa. The author invokes the 'serial founder effect' as a potential mechanism to account for changes in handaxe technology as a result of dispersal events. The 'serial founder effect' describes a bottleneck situation that typically occurs when sub-populations separate from their larger mother-population. The result is a correlated reduction of in-group variance with increased geographic distance from the source population's point of origin (*ibid.*: 2). It is asserted that, by analogy, processes of social transmission should be equally affected by this reduction of in-group variance. In other words, some general changes in the structure of hominin populations are predicted to have a *proportional* impact on the structure of handaxe assemblages. Already this structural analogising is suspiciously formistic: not only are population-level and assemblage-level characteristics regarded as 'reflecting each other,' the link between the two is conceptualised as a rather generic type of undirected co-variation.[405] What holds populations and technologies together is a 'social inheritance' of artefactual traits, so that a modification of population structure will impact what is possibly 'inherited' by the artefacts:

> "In recent years it has been increasingly recognized that the manufacture of artefacts such as handaxes results from the process of social transmission of knowledge between individuals and across generations [18-21]. It is also been increasingly recognized that social transmission may be modeled as a mechanism of inheritance broadly analogous to that of genetic transmission [22-27]. This is not to say that these two inheritance mechanisms are identical in all respects. One obvious difference is that in the case of social transmission the ability to acquire information is not limited solely to copying biological parents; there is also the opportunity to copy more distantly related kin and unrelated individuals. Nevertheless, attention has increasingly been drawn to the fact that the evolution of cultural traditions involves a process of social inheritance, variation in the details of practice, and differential representation of given variants in subsequent generations (i.e. sorting due to various selection processes and cultural drift) (e.g.[28,29])." (Lycett 2009a: 1f.)

Reality is viewed to be ordered, but only weakly so and in a general sense of the word. Moreover, the various compartments of reality close ranks according to a 'symmetry principle.' The test-implications of this construal are the following: if the compositional structure of Acheulean handaxes traces dispersal patterns, non-African assemblages should exhibit significantly lower in-group variance than their African counterparts. This decrease in intra-assemblage variance should, moreover, mirror increasing geographic from Africa (*idem*).

Lycett (2009a) conducts a 'phylogeographic' analysis to examine whether intra-assemblage variance of handaxes informs us about the assemblages' geographic origin. For this purpose, the author records a total number of 72 individual characters on each lithic object within the 10 studied lithic assemblages. Each character documents either a distinct metric measurement, a shape coefficient, an index, a discrete value, or a feature count (*ibid.*: SI Table S1; cf. Lycett et al. 2006; Lycett 2007a, 2007b). After screening the resulting data set for artificial variable interdependencies using 'Pearson product-moment analyses,' 66 of these lithic characters are identified as independent enough to warrant further scrutiny (*ibid.*: 4). Taken together, these data are regarded to proxy the detailed object geometry of the handaxes in question. The author then employs a cladistic 'maximum parsimony analysis' to arrange the data sets according to their distance from one another (*ibid.*: 2, 4, Figure 1). In this process, all characters were treated equally, that is, were given similar weight.[406] Subsequently, a 'bootstrap analysis' is performed to assess the robustness of the identified relationships (*ibid.*: 4; Fig-

[405] As already indicated in Chapter 2, this conception of generic co-variation illustrates the formistic inclination to interpret the relationship between 'subsistence' and 'existence,' or between the 'indirectly' and 'directly' observable, as a form of *supervenience*. To recall, 'supervenience' is when two correlated, yet discrete domains of reality are stitched together in such a way that change in one domains implicates change in the other. These different domains are sometimes also termed 'levels of existence.' Change is thereby not necessarily specified and may concern merely aspects of structural organisation. 'Supervenience' is typically called upon to explain interdependencies between brain and mind (cf. Kim 1984) – it is thus a prototypical formistic strategy to circumvent the mind-body problem that results from the differentiation of reality into discrete parts.

[406] An important detail of the cladistic analysis is that quantitative measures need to be transformed into 'discrete character states.' Lycett (2009a: SI Text S1) uses a 'divergence coding method' to achieve this. This is a statistical method that helps determining the most suitable way of breaking down the recorded variability of character states into discrete units. Obviously, this entails *classification* and a 'Theory of Types,' although the latter is of course interpreted statistically.

ure 2). This test is followed up by the creation of a 'model' tree designed to represent conditions of severe raw material constraints (*ibid.*: 4f.: Figure 3). This 'model' tree is compared to the most parsimonious tree returned by the original cladistics approach. The purpose is to determine whether the results of the conducted phylogeographic analysis significantly differ from a model scenario, in which the structure of the tree is known to be shaped by locally varying raw material conditions.

Lycett (2009a) finds that his phylogeographic tree generated by the cladistics analysis is robust and conforms to the formulated geographic expectations, namely that non-African and African handaxe assemblages should group together. All African assemblages are situated at the base of the tree, whereas the non-African assemblages occupy positions higher on the tree (**Fig. 12).** The author interprets this finding as evidence for the fact that handaxe intra-assemblage variance reflects geographic distance from Africa, and the non-African assemblages must therefore represents 'derived' phenotypes (*ibid.*: 2). Since the output of the 'bootstrap analysis,' a majority-rule consensus tree, is generally consistent with this finding and the raw material 'model' tree differs statistically, i.e., in terms of the Kishino-Hasegawa test (*ibid.*: Table 1), from the original parsimonious tree (*ibid.*: 2f.), he concludes that the handaxe evidence ultimately supports the 'African Acheulean Hypothesis':

> "Parsimony analyses of the Acheulean handaxe dataset, which includes samples from Africa, the Near East, Europe and the Indian subcontinent, produced a tree consistent with the phylogeographic prediction derived from the African dispersal hypothesis. Importantly, a randomization procedure (phylogenetic bootstrapping) provided further evidence that the major African versus non-African phylogeographic pattern depicted in the maximum parsimony (MP) tree is robust. Moreover, the MP tree was also shown to be statistically different from a comparative tree constrained by the raw materials used to manufacture the stone artefacts. This latter result demonstrates that raw material parameters (long known to be a potential influence on the form of stone tools) do not constitute a confounding factor in these analyses. These results demonstrate that nested analyses of behavioural data, utilizing methods drawn from biology, have the potential to shed light on ancient hominin dispersals." (Lycett 2009a: 3)

Altogether, the phylogeographic distance between handaxe groups is reconstructed solely on the basis of the *structural similarity* among shape-based characters. The employed 'maximum parsimony analysis' thereby delivers a method of *hierarchical classification,* arranging the lithic assemblages in the multidimensional space of variables.[407] Furthermore, all of the *post hoc* assessments, including the 'bootstrap analysis' and the 'model' tree, address the 'contingency' of pattern and search for the 'normality' thereof. The goal is to detect strong 'norms' in the data-structure and, in the case of the raw material 'model' tree, to juxtapose these *empirical norms* with *theoretical norms* derived from competing scenarios. These 'ideals' are simply compared in terms of their structural congruity, indicating that lithic knowledge is corroborated following a 'correspondence conception' of truth. The fact that Lycett (2009a) puts so much effort into demonstrating that alternative candidates of explanation – i.e., locally differing raw materials – can be excluded further suggests that 'raw material' is treated as a potential 'subsistent' category; it can safely be excluded because its empirical consequences do not correspond to the patterns of the observed 'concrete' reality. All of this signals that 'population-level social transmission' and 'geographic location' work together as the explaining 'subsistent' categories. They are shown to regulate the structure of the evidence and to create strong patterns in the data but remain partially 'concealed' – the actual hominin populations and their social transmission capacities are not fully actualised in the lithic material; yet, they remain necessary to explain the discovered data-structure. That 'space' is interpreted as an ultimate 'subsistent' is not uncommon in formism.[408] It is also not unusual to identify multiple explanatory 'subsistent' categories as long as they do not logically or empirically contradict each other; put differently, the same basic particulars of 'existence,' in this case individual handaxes, may simply participate in more than a single form.

[407] This is a technique of 'numerical taxonomy' and its rationale is to organise *similarity* among artefacts and their traits on different levels: "[w]e have seen that behind this group of techniques lies the idea that objects can be similar to one another at different levels, so that the results can be represented in the form of a dendrogram: a tree representing the relationships between individuals and groups." (Shennan 1997 [1988]: 235)

[408] See Lycett (2009c) for an example of the phylogenetic study of technological ancestry deploying 'time' as its 'subsistent' category.

Archer et al.'s biogeographic approach to Still Bay point morphology

Archer et al. (2016) investigate geometric patterns in bifacial point technology of the South African 'Still Bay' – a long recognised techno-tradition of the African Middle Stone Age (MSA) featuring prominently in narratives about modern human behavioural evolution and demography. The authors' focus is the 'assessment of the homogenous nature of the Still Bay' and its broader implications for questions of human adaptation and behaviour during the MSA (*ibid.*: 59). They ask whether the shape and size variability documented in Still Bay points is continuous across different regions or whether diverging "design imperatives" were guiding the production of these points at different places (*idem*). *What is Still Bay? Human biogeography and bifacial point variability* uses a '3D geometric morphometrics' (3DGM) approach coupled with an 'Elliptical Fourier Analysis' (EFA) to address this issue (*ibid.*: 61).[409] The point of departure is the 'null hypothesis' – derived from the conclusions of previous work on the Still Bay phenomenon – according to which heightened sociocultural interaction in this period should have produced a relative homogeneity of point shapes across different regions. This hypothesis is tested with the high-resolution 3DGM shape-data gathered from the studied sample of Still Bay points. The basic reasoning is that interregional connectivity should be reflected in overall point shape similarities, while regionalisation should produce a more structured pattern of shape variability.

This construal of the research problem and its possible solutions already carries a formistic signature. Examined is the relationship between the general sociocultural organisation of the Still Bay and the shape variability of its bifacial points. A change in the structural constitution of one of the two dimensions is thought to have structural repercussions for the other. The underlying logic of reasoning stresses the general *correspondence* between the two dimensions without referring to any specifics of causality or determination. This presumed *structural* co-variation between the realm of lithic technology and the realm of sociocultural life leads to the establishment of two pairs of *analogies* – 'homogeneity' and 'continuous variability' on the one hand, and 'heterogeneity' and 'structured variability' on the other. The 'predictions' of the authors only make sense if this reconstruction is accepted.[410] It can then confidently be stated that the general structure of lithic variability at least broadly reflects back on the structural organisation of the sociocultural entities having produced this variability. The potential co-variation between lithic technology and a differentiated landscape is thereby reinforced by invoking aspects of 'design theory' and the tenets of general ecological reasoning (Archer et al. 2016: 60; cf. Torrence 1989c; Bousman 1993; Bleed 1997). The purpose of this body of theory is to bolster the general rationale of the study and to call attention to the range of factors that might have contributed to the total shape variability of the studied lithic objects. This last point also shows that 'variability' is understood as a compositional variable which can 'analytically' be deconstructed into its constitutive components:

> "Variation in point design, and variation underpinned by the extent of point manufacture, re-sharpening and recycling activities provide information about different spheres of technological adaptation. It is, therefore, important to attempt to isolate these components of point variation from one another." (Archer et al. 2016: 60)

The authors' approach to bifacial shape variability is designed to isolate and remove those parts of the overall variability tied to contingent situational factors, such as reduction stage and raw material variability (Archer et al. 2016: 59, 63f.). Only the 'residual' variability, if any, may inform us, as they say, about the structure of Still Bay society. The guiding idea here is that different aspects of shape variability are the product of different underlying processes. Arguably, these processes represent the relevant 'subsistent' categories of the investigation. The fact that they need to be separated and, if possible, eliminated as potential explanatory candidates simply mirrors the formistic conception that the 'particulars' of 'concrete' existence – i.e., individual Still Bay points – often participate in different 'norms,' 'laws' or regularities. In order to examine particular 'patterns of participation,' one must

[409] See Archer et al. (2015) for a detailed presentation of the methodology and broader rationale of this approach.

[410] Although the authors explicitly use the term 'prediction,' their trajectory of inference is not based on 'predictive reasoning' in the strict sense. What they mean with prediction is simply 'correlation' insofar as some compartments of reality can be said to regularly co-vary. This understanding of prediction exploits the discrete structure of reality and the patterned correlation among its parts. It calls upon the regulatory relationship between the realms of 'existence' and 'subsistence.' Their notion of prediction is therefore significantly different from the concept's significance in 'mechanism,' where it plays a key role in *explanation*. The only exception is when the authors take the allometry of bifacial tools into account, that is, the predictable relationship between morphology and size (Archer et al. 2016: SOM esp. SOM Fig. 1; cf. McPherron 1994, 1999, 2003, 2006).

therefore also address the *interference* of 'norms,' 'laws,' and regularities (cf. Pepper 1942: 178f.). According to formism, these interferences tend to 'distort' the discreteness of experienced reality. As a consequence, the view for what is *normal* and results from the natural order of things becomes clouded (cf. *idem*).[411] Therefore, explanation and insight are only possible if one isolates the potentially interfering categories for they are all correlated with their own patterns in 'existence.' The attempt to correct for such distorting categories hence reveals the status of these factors as 'subsistent' and shows that the applied logic of research is largely formistic.

After having removed the distorting components of variability using various statistical techniques, Archer et al. (2016: 65f.) show that their 3DGM shape data of bifacial points is strongly structured along spatial coordinates. This result is based on 218 Still Bay point specimens from well-controlled archaeological contexts, each delivering 518 distinct shape coordinates (landmarks and semi-landmarks). The authors compare this pattern of point variability with the three main South African precipitation zones taken to proxy varying ecological conditions and the general distribution of sites during the Still Bay. While the ecological context of the points appears to structure the data only weakly at best (*ibid.*: Fig. 6), the archaeological site distribution seems to broadly reproduce the structure of point variability (*ibid.*: Fig. 7). Archer et al. (2016: 65f., Table 3) conduct a 'principal component analysis' (PCA) to demonstrate that the configuration of residual shape characters varies significantly between a North-Eastern and a North-Western site cluster (**Fig. 13**). Because this correlation concerns the 'pure' shape variability (raw material and allometric reduction effects have already been subtracted), they interpret these findings as evidence for the presence of different 'design imperatives' in the two groups, suggesting that regionalisation played a much more important role in the Still Bay than often argued. A closer examination of the internal data-structure of the two groupings leads to the additional conclusion that not just the shape patterns differ but also which variables interact (*ibid.*: Figs. 8, 11). The multivariate inspection of these structural differences suggests that point production in the two regions is governed by different reduction trajectories resulting in different life-history patterns (cf. *ibid.*: 68). The authors in fact argue that bifacial production starts off rather similar in the two site clusters – by producing bifacial rough-outs – and then diverges as reduction continues and points are worked out in more detail.

Two observations are important. The first is that patterns are thought to indicate a 'norm.' This 'norm,' conversely, is regarded to regulate the observed patterns. The reliance on various statistical methods to extract mean differences and other trends in the shape data illustrate this point. The differences between the identified reduction trajectories, for example, are differences in the *ideal* trajectories. The identification of such differences presupposes the recognition of order in terms of *normality* and the existence of non-observable forces being responsible for the 'normality of pattern.' All of this is certainly formistic and attests to 'subsistent' categories at work. These are to a certain extent *eternal*, that is, they delineate unchangeable truths; they are, in other words, *universals* which may be exemplified under different historical conditions in different ways. An example is the 'subsistent' category 'reduction' which corresponds to a certain correlated structure of evidence that, in principle, never changes. The same reduction effects play a role in different technologies and can be identified by using broadly similar approaches. The second observation concerns the significance of 'classes.' It should be sufficient to note that the segregation of two groups of bifacial points in conjunction with two "pockets of sites" (Archer et al. 2016: 68) relies on a correlative classification. The subsequently conducted statistical comparison between the two classes of entities simply conforms to assessment of class overlap, anchored in 'set theory.'

[411] Cf. "What, then, about a mass that is restrained from following its law, such as the lead ball held in the hand before it is dropped? As far as the formist is concerned, this law is still acting and shows itself as weight or pressure downward, but it is being interfered with another law in which this particular lead ball also participates. [...] These interferences of laws with one another as a result of the participation of basic particulars in characters with themselves participate in laws, which frequently conflict, constitute such a marked feature of formism that they deserve further illustration. [...] There is evidence, we saw, for the norm of an oak tree. A botanist or horticulturalist could tell us in great detail what is the *normal* growth and appearance of any particular variety of oak. Give the oak suitable soil, water, sun, fertilization, and freedom from other vegetation, from insects, and the like, and the normal oak will be exemplified. The law of the oak will exhibit itself in concrete existence just as the law of gravitating mass exhibited itself in the dropped ball. But plant the oak in poor soil or on a windswept hill, or in a thick forest, and it will be distorted from its normal growth just as the planet was from the normal gravitational path. This distortion will be a resultant of the forces of other laws in which the characters of the oak participate in conjunction with normal law of growth of the oak." (Pepper 1942: 178f.)

In general, the formistic orientation of *What is Still Bay?* is also reflected in Archer et al.'s (2016) emphasis on artefact *form*. The authors effectively argue that shape variability is able to conserve an intelligible combination of utilitarian and cultural information. They indicate that the identified reduction trajectories are likely associated with divergent mobility-environment systems. The differences in 'pure' shape can therefore be interpreted as a cultural signature. They further invoke the results of a number of use wear studies to show that functional explanations are insufficient to account for the documented variability of point shapes. These enunciations make clear that all of these factors are regarded as potential *form*-givers and that *form* is conceptualised as a highly *plastic* category. *Form* is 'shaped matter' and many different factors may contribute to the process of 'shaping.' Differences and similarities in artefact form are therefore the central axes of lithic inquiry. In the case of the Still Bay, stark differences in the form-aspects of bifacial technology are taken to signal the relative cultural isolation of Still Bay populations. This, in turn, is taken to suggest that technological *convergence* and *independent innovation* are responsible for the particular recurrence of form we recognise today as the Still Bay point (*ibid.*: 70). *Form* is really conceptualised as a 'historical document' that records the totality of processes which brought it into existence:

> "Stone artefacts widely considered diagnostic in the identification of some of these [MSA] traditions are the products of dynamic sets of interactions between ecological contexts, technological capacities and cultural tendencies." (Archer et al. 2016: 70).

All things considered, Archer et al.'s (2016) approach seems to be a clear example of formistic reasoning. The authors' emphasis of the complexity of past reality is also a homage to the 'dispersivity' of fact and the related difficulty of coming to grips with a world in which many determinative forces participate in the forms we observe. Within this complexity of pattern, Archer et al. (*idem*) maintain that 'culture' forms an important 'subsistent' category – a 'subsistent' that is often not taken seriously enough. It is notable that 'culture' is thereby *spatialised*. Cultural differences among populations are primarily expressed in terms of geographic differences between lithic assemblages. Again, this simply attests to the fact that time and space are typically seen as the 'standard' categories of 'subsistence' which, because of their elementary status, must play a certain role in any explanation. Pepper (1942: 174) has seen this quite lucidly and noted:

> "[...] it would seem probable that all concrete existences participate in the laws of physical time and space, whatever other forms they may also participate in."

What is Still Bay? puts forth the cognate argument that all lithic particulars can be shown to participate in the basic spatial norms of culture, independently of other forms they may participate in.

4.1.4 ***Handaxe symmetry, hominin cognition, and abstract thought***

The fourth and last glimpse into Anglophone lithic formism is granted by the discourse on the status and significance of Lower Palaeolithic handaxes (or bifaces), a subset of the so-called 'Large Cutting Tools' (LCTs) (e.g., McNabb et al. 2004; Petraglia and Shipton 2008; Shea 2013a 55-64). The long-standing question of the purported place of these certainly enigmatic stone tools in human evolution continues to ignite many lively discussions in the field of lithic studies (e.g., Wynn 1979; Clark 2001; Lycett and Gowlett 2008; Gowlett 2015; Wynn and Gowlett 2018). Traditionally, the issue of *imposed form*, especially *symmetry*, has occupied a prominent position within these debates (Hodgson 2010, 2015; White and Foulds 2018; cf. Abramiku 2012: 188-192). On closer inspection, one might in fact speak of an entire 'symmetry discourse' centred on broader questions of hominin cognitive and social evolution, where researchers attempt to establish the precise sociocognitive implications of the material handaxe record, if any (e.g., Mithen 2003; Hodgson 2009, 2011; McNabb et al. 2018). This discussion has engendered two opposing groups of scholars – the first group argues in favour of symmetry-patterns and their evolutionary significance, whereas the second rejects the reality of the pattern, its significance, or both (cf. e.g., (Gowlett 1984, 2006; Leakey and Roe 1994; Ashton and McNabb 1994; McPherron 1994, 2000; Wynn 1995, 2000; Kohn and Mithen 1998; Kohn 1999; Nowell 2000; Mithen 2003; McNabb et al. 2004; Machin and Mithen 2004: 668f.; Machin et al. 2005; Lycett 2008; Machin 2009; Hodgson 2009; Iovita and McPherron 2011; Spikins 2012; Gamble et al. 2014: 119-123; Cole

2015; McNabb 2013, 2017; McNabb and Cole 2015; Iovita et al. 2017).[412] The logic of this debate is illuminating and it is worth unpacking some of its details.

Mithen (1996), for example, points out that

> "[t]he most characteristic artifact produced by Early Humans was the handaxe. Even a brief look at handaxes indicates a number of significant differences from those artifacts produced within the Oldowan tradition. They often display high degrees of symmetry, sometimes simultaneously in three dimensions, and indicate that the knapper was imposing form on the artifact, rather than just creating sharp edges as with an Oldowan chopper. [...] To achieve such symmetry in form, longer knapping sequences were required. [...] Planning ahead is essential if symmetry is to be achieved, and maintained as the piece is developed. [...] Consequently to produce standardized forms, the knapper needs to exploit and adapt his or her toolmaking knowledge, rather than just follow a fixes set of rules in a rote fashion." (*ibid.*: 132f.)

Abramiuk (2012), reviewing the whole discussion, similarly asserts:

> "The Acheulean handaxe was essentially a large, teardrop-shaped tool, the rounded end of which could be held in the hand and swung in a chopping motion with the beveled end directed at the target (Bordes 1968: 64-76). [...] From a cursory inspection of Acheulean tools, it is evident that their makers had a definite sense of aesthetics; [...] What this suggests is that it was not only important for *Homo erectus* to have a point or an edge with which to work; it was also important to have a tool with a definite shape, as well as a tool that might be useful for unforeseen tasks in the future." (*ibid.*: 185)

Coolidge and Wynn (2009) add:

> "Archeologists often overlook a fact about bifaces that is really quite important. They were the first tools that probably existed in the minds of their makers as tools. In non-human and Mode 1 tool use the target was task completion – cracking open a nut or butchering a carcass – and the tools were components of those procedures. They did not exist as things apart from those contexts. But bifaces did. Hominins made bifaces, carried them around, and used them again and again as tools and as sources of flakes. The role of tools had changed. Instead of being elements in a procedure, tools themselves had acquired the status of permanent objects in hominin daily life, even when not in use." [...]Bifaces remain a perennial puzzle for archeologists. On the one hand their "toolness," and imposed shape, were very different from what apes do and suggest that *Homo erectus* had a very different relationship with tools. On the other hand, the complete absence of innovation, and the dogged conservatism of the form (for well over 1 million years!), indicate that the relationship was also very different from the one modern humans have with tools. In this sense, at least, *Homo erectus* was neither ape nor human." (*ibid.*: 112f.)

These enunciations all posit that the *form* of a handaxe – a specific configuration of shaped matter – can be said to stand for some more *abstract concept* or *idea*. The material recurrence of the handaxe as a stable and recognisable form, in other words, can only be explained by new, but similarly stable non-material conditions. The latter 'resist' complete materialisation – they are discrete, non-material entities – yet must be recognised as the *sine qua non* of the 'existence' of handaxes. The handaxe is thus nothing else than the historical *exemplification* of a more general category of existence. It is no great leap to suggest that this more fundamental 'level of existence' must be a pure, quasi-universal category, especially since the handaxe phenomenon persists over thousands and perhaps millions of years in the archaeological record. In the above-quoted cases, these categories are 'planning depth,' 'standardisation,' 'aesthethic sensibility,' and 'tool concept.' They relate features of handaxe form to the realm of hominin cognition and posit that the two represent *correlated realities*. The emergence of the handaxe form in the archaeological record can therefore be said to signal the emergence of a new type of cognition. This construal clearly implies that various cognitive categories, or simply 'cognition' itself, are mobilised as 'subsistent' categories, and that the material configuration of a handaxe is viewed to point to a horizon *beyond* materiality (cf. Pope et al. 2006). Put differently, the handaxe embodies a 'norm,' and this norm informs about the essence of being a handaxe-producer. The formistic logic of this line of reasoning is undeniable.

The controversy on the recognition of patterned 'symmetry' – whether defined as 'plan view,' 'partial,' 'edge-on,' or 'basal' symmetry – in the handaxe record and its potential meaning further clari-

[412] It is notable, although I cannot go into the details here, that much of these discursive dynamics appear to be a product of the historical alliance between British *Cognitive Archaeology* and strands of *Evolutionary Psychology* (see esp. Mithen 1996; Gamble et al. 2014).

fies this formistic figure of inference. After taking stock of a critical argument by McNabb et al. (2004) that early South African handaxes do not seem to be particularly symmetric at all, Abramiuk (2012), for example, emblematically states:

> "This could mean two things. First, early Acheulean tools were not intended to be symmetrical; that is, early *Homo erectus* lacked a concept of symmetry. Second, early *Homo erectus* did maintain a concept of symmetry but was unable to express the concept behaviorally. Third, early Acheulean tools, although asymmetrical to us, may have appeared symmetrical to *Homo erectus*." (*ibid*.: 188f.)

This statement unambiguously showcases that a shared artefact form – the handaxe – is thought to indicate a shared 'mind frame.' What this 'mind frame' exactly is, of course, remains a matter of debate. Even McNabb et al. (2004) who have so poignantly criticised the notion of an empirically recurrent pattern of early handaxe symmetry, maintain that while hominins at this time apparently lacked a concept of symmetry, they clearly shared the 'mind frame' of an LCT – a phenomenon they refer to as 'conceptual standardisation.' Furthermore, one of the authors has subsequently suggested that the lack of the ability to express the concept of symmetry might have been due to certain underdeveloped brain functions (Hodgson and McNabb 2005). This suggests that even those who criticise the 'symmetry' as a cognitive 'subsistent,' adhere to the same general logic of explanation.

Abramiuk's (2012: 188-191) recap of the symmetry debate is also revealing for another reason: he explicitly refers to the possibility that the respective hominins 'maintained a concept of symmetry but did not express it at this moment in time.'[413] He (*idem*) thereby explicitly grants that certain mind frames might have been present, but were not actuated, manifested, or exemplified. Not only is this terminology doubtlessly formistic – it clearly evokes the 'principle of exemplification' – it also draws attention to the categorical distinction between *capacities* and *expressions*. This distinction is such a marked characteristic of formistic thought that it deserves closer consideration. Perhaps most importantly, the polarity between 'capacity' and 'expression' suggests that even though 'existence' and 'subsistence' are correlated, they are *not identical*. This secures the 'discreteness' of reality and the separate existence of the realm of non-empirical, 'ideal' entities. In addition, differentiating between 'capacities' and 'expressions' drives home the formistic insistence on the fact that some principles, laws, regularities, and norms are of such a nature that they cannot fully be particularised, let alone at all times and in all places. The polarity between 'capacity' and 'expression,' in other words, legitimises the formistic belief in 'subsistence.' Moreover, it expounds the possible *aspectual dimensions* of exemplification in formism. This figure of thought further reinforces the 'subsistence'-'existence' boundary since it asserts that only 'subsistent' categories can stand for *universals* –entities that appear to be 'eternal' in a certain sense. The question is therefore always *how* these categories are exemplified and it is far from clear whether they do always 'show themselves' in a similar way. The unit and mode of exemplification may accordingly vary across time and space; different aspects of the same form may refer back to different 'subsistent' categories. Abramiuk's (*ibid*.: 191) consideration, following Wynn (2002), that 'broken or partial symmetries rather than whole symmetries concerning the entire tool may have been important to some hominins' reflects this *problem of exemplification*. This difficulty seamlessly flows into the problem of *multiple realisability*.[414] The idea of 'multiple realisability' picks up the formistic presumption that there are 'levels of existence' and that these broadly co-vary; yet, more fundamental levels – those which are exemplified by their 'derived' levels of existence – may be expressed in a multitude of different ways. This delivers the formistic interpretation of *equifinality*. According to the formist, 'equifinality' of form is therefore a problem of 'subsistence.'

The general strategy to infer cognition from artefact form complies with Abramiuk's (2012: 146-152) *conditional approach for inferring cognitive capabilities*. This approach is primarily concerned with explaining how form, which itself stands for certain behaviours, has resulted from particular capacities. The relationship between 'capacity' and 'expression' is then formulated as a conditional

---

[413] For essentially the same situational-functional argument *contra* McNabb et al. (2004), see Machin and Mithen (2004: 668f.).
[414] The concept of 'multiple realisability' (MR) is widely used in the philosophy of mind to address the problematic relationship between 'mental states' and physical 'brain states' (e.g., Fodor 1974; Sober1999). The contribution of MR to this debate is that it allows us to make sense of the correlated nature of the two phenomena and to accept the 'existence' of both of them ('levels of existence'). In addition, the same 'mental state' may be implemented by varying 'brain states.' MR arguments are arguments against reductionism. 'Formism' guards itself against 'mechanism' here.

statement.[415] The conditional approach consequently relies on *formal* reasoning, taking advantage of the patterned character of reality on which formistic inquiry is based. A classic conditional clause, following Abramiuk (*ibid*.: 147) would be 'if p, then q' where 'p' represents the *antecedent* and 'q' the *consequent*. Neither 'antecedent' nor 'consequent' are identified as variables, they both function as conditions. In the given example, more precisely, 'p' constitutes a *sufficient condition* for inferring 'q.' Yet, it is similarly valid to state that 'q' is a *necessary* condition for 'p.' Thus, the conditional approach reiterates the formistic logic of 'necessary and sufficient conditions' introduced earlier in this part of the chapter. The conditional approach is intuitively appealing, typically cherishes simplicity of reasoning, and represents a 'substrate independent approach' (*ibid*.: 151). It can be employed to study the behaviour or cognition of any organism and is therefore especially suitable to be used in comparative research programmes.

Gowlett's (2006) account of the significance of bifaces, for instance, can be viewed as an exemplification of this general logic of inquiry. He declares that his research

> "[…] considers "what" bifaces are at a deep level, arguing that they inform us richly about the nature of abstraction and its origins, and that they inform us too about the difficult relation between human knowledge "in theory" and knowledge "in practice", and about the interface between function and style." (*ibid*.: 203)

and adds that

> "[t]he idea of form is crucial – almost every archaeologist will start from the intuitive position that they know what a biface is – even if they then proceed to argue that bifaces are not products of an intended design. Here, however, we encounter a problem, reflected in archaeology in a traditional dichotomy of form studies and function studies. Some emphasize the form and its abstract concepts. Others can see no need for such form to be intended by early humans, and emphasize the role of function, arguing its ability to generate form as a side-effect or epiphenomenon." (*idem*)

This brings us to the problematic distinction between 'form' and 'function.' Quite often, this distinction is simply indicative of clashing 'mechanistic' and formistic perspectives on the lithic record. While the latter consider *form* as primary and look for correlations between 'form' and 'function' – 'function,' then, becomes just another possible 'subsistent' category – 'mechanists' regard lithic objects as machines and are interested mainly in their efficacy, that is, their function within hominin behaviour. The 'mechanist' is sceptical about artefact form and tends to delegate it to the realm of mere 'appearances.' The relationship between 'form' and 'function' thus always needs to be *substantiated*. In formism, to the contrary, 'function' is a relevant 'subsistent' category from the beginning, one that potentially *interferes* with other 'subsistents.' Functional explanations, therefore, are rarely actively pursued, but functionality instead becomes a focus of inquiry when scholars seek to debunk such explanations. Multiple strategies have been adopted to establish the 'more-than-functional' significance of handaxe geometry in formistic lithic research. Typically, the goal of these approaches is to reinforce the idea that the morphological class 'handaxe' is truly a 'natural kind'; that is, represents a *form* in the proper sense of the concept – i.e., a strictly *imposed form*. To show that handaxe form appears to be 'over-determined' or 'over-designed' – i.e., cannot fully be explained by the functional or adaptive dimensions of handaxe use – is a classic manoeuvre to present hominins as the relevant 'imposers.' In the case of the symmetry issue, it may for instance be demonstrated that a symmetry of form does not increase the functional performance of the objects in questions (e.g., Machin et al. 2007) and also unlikely to emerge as a by-product of handaxe manufacture and maintenance (e.g., Wynn 1995: 14).[416] Inquiries such as these motivate the conclusion that the significance of handaxes must lies beyond the utilitarian realm.

[415] In the context of the Levantine Mousterian, Kerry and Henry (2000: 242) for example explain: "[u]ltimately, if we are to evaluate the contextual model or other cognitive models, we need to identify nonambiguous linkages between specific conceptual domains (e.g., symmetry, horizontality, conservation, numbers of elements in structure mapping) and certain artifact attributes. The attributes need to be quantifiable as to the degree to which the domain is achieved, and the attributes need to be ones that cut across specific lithic technologies." This structural equalisation between 'capacity' and 'expression' is typical for 'formism' and directly derives from its theory of cognitive criticism centred on 'correspondence.'

[416] Symmetry as a by-product is problematic for the 'formistic' argument because, as Abramiuk (2012: 192) readily maintains, a by-product contradicts the hypothesis of symmetric handaxes being "manifested ideals." This reference to the notion of 'ideal' is not coincidental but gives voice to the 'formistic' category of *abstract ideas* which are not fully particularisable.

It is no coincidence here that in the face of many competing 'subsistent' categories and the resulting need to narrow down the space of explanation, the favoured 'subsistent' categories are regularly secured by 'abductive' reasoning – i.e., *inference to the best explanation* (Harman 1965; cf. Poston and McCain 2017).[417] 'Abduction' thereby simply ensures that the respective 'subsistent' categories reflect the 'best' explanation currently available for the observed patterns of form in 'concrete' existence. Thus, 'abductive' reasoning in formism entails the argument that an encountered form is more likely to exemplify the 'subsistent' category in question than other competing 'subsistents.' Yet, because formists have no problem accepting that similar forms may participate in a number of different 'laws,' 'norms,' or 'regularities' (cf. Pepper 1942: 178-180), *form* may easily be conceptualised as a *kaleidoscope* – as reflecting back on many interfering 'subsistent' categories at the same time. 'Interference' interpreted in this way of course becomes an enabling factor of inquiry since central tendencies in artefact form can be regarded to capture the cardinal dimensions of societal wholes. A notable example of this cognitive strategy is Machin's *The role of the individual agent in Acheulean biface variability. A multi-factorial model* (2009). In prototypical formistic style, Machin argues that handaxes must ultimately be regarded as microcosms of hominin society. She offers a poignant account of handaxe form that stresses the latter's *partial superposition* on *most* of the potentially relevant categories of 'subsistence' (i.e., aesthetics, style, sociality, cognition) (**Fig. 14**).[418] In this way, the complexity of handaxe design can be grasped as a *structural convergence* between artefact form and hominin society, again evoking the formistic principles of 'similarity' and 'correspondence.'

Arguably, much of the discursive space of explaining Lower Palaeolithic handaxes can be understood as a 'give and take' between proponents of different categories of 'subsistence.' The dynamics of discourse can hence be described as a *struggle of subsistent categories*. Scholars have for example proposed the 'subsistent' categories of 'tradition' (e.g., McNabb et al. 2004; Lycett and Gowlett 2008), 'signal/symbol' (e.g., Kohn and Mithen 2009; cf. McNabb 2012b), 'sociality' (e.g., Spikins 2012; Gamble et al. 2014: 123-126), and, more recently, 'hominin biology' (Corbey et al. 2016 and replies by McNabb 2017; Hosfield et al. 2018; and Wynn and Gowlett 2018) or 'latent solution' (Tennie et al. 2017). All of these approaches consciously or unconsciously embrace the ancient Greek tenet of 'hylomorphism' – the idea that matter takes particular forms because of reasoning not related to matter itself. This view often entails the assumption, as we have seen, that *matter* and *form* are the two main substances of which the realm of 'concrete' existence is made. All other entities, including concepts, ideas, and more abstract features of reality such as society, tradition, or culture are situated in the realm of 'subsistence'; they are the potential reasons for why matter takes particular forms. The resulting mode of inquiry is thoroughly formistic.

Two prominent 'mechanistic' angles of critique are worth mentioning here because they directly refer to this general formistic pattern of reasoning. The first is the so-called 'fallacy of the finished form' or 'fallacy of the desired end product' (cf. Davidson and Noble 1993: 372; Dibble et al. 2017: 816-821). Critique of the idea of a 'mental template' falls into the same category (cf. Ashton and White 2003; Marks et al. 2001; Chase 2008, 2016). In contrast to formists, lithic 'mechanists' are highly suspicious of artefact *forms* which they categorise as mere 'appearances.' Such appearances, according to 'mechanists' cannot be taken at face value. Without any principle of determination linking form, mechanism, and case, form-centred explanations remain 'empty' and 'ineffective' they argue. The link between 'subsistence' and 'existence' that formism seeks to establish, is too unspecific and generic for die-hard 'mechanists.' It is thus not a big stretch to suppose that some of the major division lines within the handaxe discourse can probably be reconstructed as a product of the lasting tension between 'formism' and 'mechanism' in lithic studies.

[417] The classic example for 'abduction' is the problem of explaining wet grass. If grass is wet, it probably rained. However, other explanations are possible depending on the context. For instance, the proposed explanation might be the best one for England where it regularly rains, while it might be not the best explanation for Arizona where automatic sprinkler systems are used to keep the grass wet during the dry season. 'Abductive' reasoning therefore typically requires elimination of competing 'best' explanations and a specification of contextual variables – yet, one does not necessarily need to specify any causal mechanisms.
[418] See e.g. Ruebens (2012) for a similar explanatory strategy in more mundane lithic research.

4.2 **Tropes of mechanism in Anglophone practice**

4.2.1 ***Henry's dimensional approach to lithic reduction***

Henry's *Correlations between Reduction Strategies and Settlement Patterns* (1989b) provides a first illustration of 'mechanistic' reasoning in Anglophone lithic studies. The paper may be counted as an early elaboration of the 'Reduction Thesis,' but also seeks to position the study of lithic reduction sequences within a broader ecological framework. Above all, *Correlations* delivered an important methodological impulse by demonstrating the interpretive merits of a 'dimensional approach' to the dynamics of lithic reduction (cf. Tostevin 2012: 144-147). Henry (*ibid.*: 140) opposes this new approach to conventional 'morphological approaches' and regards the former as a crucial complement for the latter (*ibid.*: 153):

> "The reconstruction of a reduction sequence relies upon the elemental observation that throughout the developmental life of a stone tool, from raw material acquis[i]tion through fabrication and use, the morphological changes that occur are subtractive in nature. However, conventional analytical procedures have focused on morphological, as opposed to dimensional, attributes for reconstructing reduction sequences (Collins 1975; Bradley 1975). […] Conventional means of analysis allow for a general reconstruction of reduction strategies, but they ignore an important source of information, i.e., the trend of diminution during the course of an item's fabrication and use-life." (*idem*)

The 'dimensional approach' shifts the attention from the retouched elements of lithic assemblages (tools) to their un-retouched counterparts (the plain *débitage*). According to Henry (1989b), reduction sequences are best understood by first examining the dimensional relationships between cores and their associated blanks; only in a second step may the results of this analysis be compared to the metric and non-metric data of lithic tools. Based on some general *theoretical considerations*, the author outlines a basic *mechanical process* which underpins any reduction sequence and is first and foremost 'reductive,' i.e., directed and irreversible. This recognition is central to Henry's account since the effects of lithic reduction, then, cannot simply be 'unmade' or 'overwritten,' especially when plain *débitage* is concerned. Henry (*ibid.*: 140f.) asserts that each reduction sequence thus *by necessity* authors a general trend of raw material "diminution" resulting in a decrease in core size and associated blank size (**Fig. 15**). Because general theory about technological organisation and hunter-gatherer mobility indicates that the 'reduction stream' is often spatially segregated, this fundamental principle can be analytically exploited. Within any given lithic assemblage, one can compare the dimensionality of the preserved core facets, blanks, and tools in order to gain a "more precise understanding of the reduction stream within each of the broader segments (or stages), as defined conventionally" (*ibid.*: 140). The crux of the equation is the change in perspective from individual artefacts to 'populations of artefacts.'[419] These populations of artefacts are agglomerative entities – i.e., non-structured artefact totalities. By means of population thinking, it becomes possible to assess the general trends in the dimensionality of these different artefact categories. Since lithic reduction is –as the term implies – *reductive* and there is a causal correspondence between the blanks and their original core facets, one would expect that lithic reduction *in situ* would produce similar mean values of core facet and blank dimensionality. Similarly, dimensional differences between core facets, blanks, and tools may tell us whether tools have been manufactured prior to *in situ*-reduction or whether it is possible that tool production instead occurred on-site. Consequently, the comparison of the dimensionality of core facets, blanks, and tools provides a *relative measure* for the degree of core exhaustion and the possible mobility of tools (*ibid.*: 141). Since one can compare these measures to other conventional measures for core reduction, for example the relative ratio of cortex-bearing blanks or the dimensionality of primary elements, core reduction intensities can be estimated with high accuracy.

This pattern of reasoning shows that Henry's (1989b) 'dimensional approach' is firmly rooted in a mechanistic understanding of lithic reduction sequences. Lithic reduction is considered a relative-

[419] This approach is sometimes also labelled 'aggregate analysis' or 'mass analysis' (cf. Andrefsky 2001: 3-6). As an instance of 'population thinking' in lithic research, it primarily represents a *methodological* manoeuvre. The goal is to isolate assemblage-level trends and regularities that sometimes give lie to individual artefact differences. In other words, not every artefact needs to embody the respective trends and regularities (cf. Porter 1986). Nonetheless, this position is not at all 'synthetic' since it still accepts the doctrine that these assemblage-level characteristics can be repatriated to the configuration of all aggregated artefact-properties. As Ariew (2008) puts it, population thinking adopts a 'bottom-up' approach to population-level phenomena.

ly closed, mechanical core-blank system – a lithic machinery – operating by the interlocking of various successive knapping events. Each event has unequivocal and largely inevitable consequences on future core states which, in turn, precondition the results of future knapping events. The sequence of reduction is recast as a *chain of causal adjustment*. The basic regularity of reduction is the *co-diminution* of cores and blanks during the knapping process. In the language of Pepper's mechanism, this regularity can be identified as the 'primary law' of lithic reduction. The 'law' specifies the configuration of 'primary qualities' in the lithic machinery, typically expressed in exact quantitative terms.[420] 'Primary qualities' are the elementary observable features of lithic parts – i.e., individual artefacts – which are attributable to these parts alone and are relevant for the kind of action – i.e., mineral detachment – powering the core-blank machinery. In *Correlations*, the key 'primary quality' of lithic artefacts is their dimensionality since the outlined 'primary law' of lithic reduction *predicts* directed change especially in this domain of variables; cortex is also defined as a 'primary quality' since it similarly indicates the position of reduction and helps identifying what Henry calls "primary elements."[421] This conceptualisation of the relationship between the lithic machinery and its 'primary qualities' presupposes a 'field of locations.' The 'field of locations' defines the precise position of each lithic part in the spatiotemporal field inaugurated by a reduction sequence. The 'field of locations' therefore determines what can be 'cause' and what is 'effect' and thereby fixes the 'function' of each part in the machine. Henry's Figure 1 (cf. **Fig. 15**) provides nothing else than a graphical representation of the general workings of the lithic machine and the nature of its associated 'field of location' – the figure may be classified as *theoretical imagery*.[422] The whole point of the 'field of locations' is that each spot in the field can only be occupied *once* and by a single lithic part. Consequently, the 'field of locations' opens up a Newtonian space in which 'distances' can be measured in *absolute* fashion. If one knows the 'primary laws' of the machine that inaugurates the field, in other words, one can unambiguously infer the field-position of the attendant parts by analysing their 'primary qualities.' Henry's use of artefact dimensionality and cortex value are authorised by this general understanding of lithic reduction. With Pepper (1942), one may additionally point out:

> "To this absolute space of externally related locations was gradually added an absolute time similarly conceived as an infinite one-dimensional manifold of externally related dates. The dimension of time was not even at first amalgamated with the three dimensions of space. Space was rather conceived as traveling intact like a freight car along the track of time. Thus one could have the identical space location at different times. Space, in other words, was external. It was changeless though it did move bodily from date to date." (*ibid*.: 199)

This conceptualisation of the reduction process has an important epistemological consequence. The only discrete element that is left in the reduction sequence are the lithic parts themselves. Since each part occupies an exact and unique position in the 'field of locations' and since parts are causally enchained, this view greatly promotes a *continuous* understanding of reduction. The variables that define the parts making up the chain of reduction gradually merge into one another. The mechanistic interpretation of 'field' underlines this understanding. A field structure is the 'integrated' unobservable cause for the observable workings of the machine; the field unifies the machine as a whole and removes any remaining discreteness by means of 'integration.' This view opposes what Henry (1989b: 140) terms the conventional approach to lithic reduction, discriminating between four broader reduction stages. This is precisely where radical mechanists disagree with the exponents of almost all other world theories.

Henry's (1989b) critique on the residual discreteness of lithic reduction is conveyed by his notion of the 'reduction stream.' This metaphor of the *stream* is certainly instructive. A 'stream' represents a flowing entity whose constitutive elements grade into each other, so that they are hardly individualisable anymore. The 'stream' implies a steady transition of character states and a continuous movement of matter. It presupposes clear-cut directionality and profuse structural integratedness. A 'stream' can hardly be said to proceed in stages. It is this notion of the 'stream' that the author harnesses in order to characterise the process of lithic reduction. The key idea here is 'nominalistic,' posit-

[420] See Chapter 2: esp. **Box 7**.

[421] Primary elements comprise plain *débitage* with more than 50% cortex, whereas blank elements are defined as plain *débitage* with less than 50% cortex (cf. Tostevin 2012: 144).

[422] See Chapter 3 for a general discussion of the role of theoretical or conceptual imagery in specifying test conditions and in laying out the workings of the world within Anglophone lithic research.

ing that *only particulars* can be said to 'exist' (cf. Pepper 1942: 198). Reduction 'stages,' by contrast, amount to 'ideal' entities and mechanists are generally sceptical about the existence of such entities. Henry's 'aggregate analytical' approach outlined before entails 'population thinking' (*sensu* Mayr 1959, 1991; Sober 2006) insofar as strong 'essentialism' is rejected and only individual-based variation granted.[423] The basic research orientation articulated by *Correlations* is therefore clearly mechanistic.

Representing lithic reduction as a machinery governed by 'primary laws' allows Henry (1989b) to formulate precise *test expectation*. The reason is of course that the specific articulation of 'primary qualities' in the 'field of locations' causes the 'primary qualities' to change in a directed and thus largely *predictable* manner. 'Predictability' – in accordance with the adopted methodological approach – is interpreted as a population-level phenomenon. This 'predictability' of patterns in artefact dimensionality is rooted in the mechanistic insistence on the 'specifity of response,' the fact that each knapping event, as a function of its position in the 'field of locations,' has highly specific consequences for both its products and future knapping events. The functioning of the lithic machine is *strongly determined*. Henry's core expectation is that there is an *equivalency* between cause and effect and hence a co-diminution of artefact dimensionality when technologically relevant groups of artefacts are compared.[424] Any observed *deviation* from this 'equilibrium condition' can be interpreted in terms of reduction intensity, mobility, and the potential of spatial segregation within knapping activities (*ibid.*: 141). The author provides two examples of possible patterns of deviations that would indicate that the assemblages in question do not represent the whole reduction sequence.

These two *theoretical situations* describe opposing ends on the spectrum of lithic reduction (Henry 1989b: 141, Figure 2; **Fig. 16**). Each of the two situations is characterised by specific relationships between the three technologically relevant artefact sub-populations and concerns the configuration of their 'primary qualities.' Figure 2A (cf. **Fig. 16A**) shows a close overlap of the dimensionalities of blanks, primary elements, and core facets, with the blank population hosting the smallest and the population of primary elements the largest artefact dimensions. This situation suggests that the present cores are not fully exhausted yet and that some cores might even be missing, for example because they were transported to another location. Figure 2B (cf. **Fig. 16B**), by contrast, shows a much more partitioned picture. Here, the size of blanks and core facets overlap, but occupy the lower part of the figure, with core facets being often smaller than blanks. Primary elements in this scenario only overlap with the largest blanks and generally tend to be larger than both blanks and core facets. This configuration points to high degrees of core exhaustion and a nearly complete reduction sequence. Building on these theoretical insights, Henry's proposition is that statistical differences in the relative overlap between blank, primary element, and core facet dimensionalities should be informative about differences in reduction activity and potential import-export dynamics. He (*ibid.*: 140, 144) suggests that these assemblage-level differences can be used to track nomadic mobility systems and human ecological adaptations.[425] Henry's example of Epipalaeolithic land-use in Southern Jordan will suffice here as an illustration (*ibid.*: 141-150).

Henry (1989b: 141) analyses nine Epipalaeolithic sites from near the Jordanian Plateau comprising fourteen individual assemblages. His main argument is that these sites, which occupy different elevation zones across the southern edge of Jordanian Plateau and the neighbouring lowland regions, were once integrated into a larger 'transhumant' settlement system (*ibid.*: Figure 3; cf. Henry 1986, 1987, 1989a, 1995).[426] The goal, drawing on Binford's (1979) concepts of 'personal' and 'situational' gear, is to elucidate that the composition of lithic assemblages changes relative to specific activity profiles on the seasonal mobility cycle. The analysis of plain *débitage* dimensionality is therefore complemented by an examination of tool dimensionality and the structure of toolkits (Henry 1989b: 144-146).

[423] Cf. Ariew (2008).
[424] Pepper (1942: 190) notes: "[…] since we found that we could substitute kilogram bricks for the tree stump and so increase the precision of our description of the machine [i.e., a lever] for that end of the bar, it follows that we can do the same for the pressure of the arm at the end of the bar. […] This is the fact of balance. It is important because it exhibits the equivalence of push and pull. The kilogram bricks for the tree stump and the arm are now seen to be just equal and just alike. We might have thought of the stump as a passive pull and of the arm as an active push. We now see that push and pull can be substituted for each other."
[425] For the purpose of assemblage-level analysis, Henry (1989b: e.g. Table 3) regularly collapses the overall variability of dimensional artefact values into statistical parameters of entire assemblages. This facilitates the direct comparison between different assemblages and helps isolating the main trends of reduction for each individual assemblage.
[426] Broadly understood, 'transhumance' describes a mode of mobility in which nomadic groups alternate between relatively fixed summer and winter pastures. These pastures are often defined relative to elevational and topographic gradients.

In the first step of the analysis, the author distinguishes between Epipalaeolithic sites of differing elevation belts (i.e., lowland, highland) and intensity of occupation determined by factors such as thickness of cultural layer, site orientation, and artefact density. Henry (1989b: 149) reveals that there is a correlation between elevation-type and the character of site occupation: higher elevations tend to harbour smaller, dispersed sites near flint outcrops, intermediate altitudes tend to be associated with small and shallow occupations, and low elevations seem to host primarily large and deeply stratified sites that are often situated close to water bodies (cf. *ibid.*: Figure 3, Table 1). He further shows that on a general level, the structure of the accompanying toolkits and production ratios (i.e., blanks per core, tools per core, tool proportions to all blanks) also differ between these three groups of sites (*ibid.*: 144, Figure 4, Table 2):

> "The differences in the variability between assemblages are consistent with the proposed differences in site types. The more ephemeral occupations of the piedmont sites are likely to have been associated with fewer and more site specific tasks than those conducted in the longer term occupations of the lowland shelters. Therefore, greater variability between the tool-kits of the piedmont sites should be expected." (Henry 1989b: 144, 146)

This dichotomy between lowland and highland sites is also found to be correlated with major differences in lithic *production efficiencies* (Henry 1989b: 146). Whereas higher elevations are characterised by generally fewer blade and bladelet *débitage* per core than the lower elevations, lower elevation sites are more varied in blank productivity and seem to disintegrate into two groups of sites: the first resembling the higher elevation sites in blank productivity, and the second being almost three times more productive (*idem*). Henry suggests that this pattern, in contrast to common intuition, cannot be explained in terms of raw material economising behaviour (*ibid.*: 147). Rather, these differences must be explained by the nature of the reduction sequences inferred by the 'dimensional approach.'

In the second step of the analysis, Henry (1989b) compares the results of his conventional analysis with the dimensional lithic data in an effort to explain the observed variability and to effectively link it to human ecology during the Jordanian Epipalaeolithic. Again, the author identifies a different pattern of core reduction when the lowland and highland sites are juxtaposed. He demonstrates that the lowland sites exhibit shorter primary elements and core facets than the highland sites (*ibid.*: 147). In fact, the primary elements are even shorter than the average bladelet (*idem*). Henry consequently concludes:

> "These data suggest longer productive lives for the lowland cores, but their facet lengths, being only about 2mm shorter, on the average, than the lengths of associated bladelets, indicate that the lowland cores were still far from exhaustion." (*ibid.*: 147f.)

The highland sites, by contrast, yield very similar dimensional values for blank size, core facet size, and the size of primary elements (Henry 1989b: 148). In the words of the author (*idem*), the relationship between the dimensionality of these artefact groups "trace an unbroken reduction stream from primary element, to core facet, to bladelet." Henry argues that this reduction signature indicates that human occupation in the highlands was of a different character (cf. *ibid.*: Figure 7). He interprets the data as suggesting that occupation was brief and linked to a set of activities exploiting the full breadth of the reduction sequence (*ibid.*: 148). Since the metric mean distance between the length of the three relevant artefact groups is extremely small, he infers *short* but *complete* reduction sequences:

> "Thus both the pattern of reduction and the dimensions of the piedmont assemblages are consistent with what one would expect in the context of ephemeral camps, where cores were used briefly in the production of a few bladelets for the expedient manufacture of tools." (*idem*)

According to Henry (1989b: 149), the only way to account for the puzzling discrepancy between the high productivity of blanks and the low degree of core exhaustion in the lowland sites is by postulating the import of laminar blanks from the highlands.[427]

---

[427] This is an instance of mechanistic 'abductive' reasoning. The postulation of blank-import is the *best* explanation because the problem of lithic site-signatures is framed as a problem of a *unified* settlement system. With Pepper (1942), we can say that this settlement system represents a higher-level machine regulating the nature of site occurrences in geographic space. The 'primary law' of this system is 'transhumance,' i.e., the necessary transition of populations from the lowlands to the highlands and other way around in specific seasons of the years. Each site, then, comes into view as a somewhat fixed position in the system's 'field of locations.' As a consequence, if the internal reduction structure of an assemblage is contradictory, as in the case of lowland sites, this must be interpreted as the effect of another node in the system. Because the system is constructed around the duality be-

Correlations ultimately proposes that this overall organisational pattern of lithic technology can best be understood by a shift in procurement strategy that must have paralleled the transition from the lowland to the highland occupations, and *vice versa* (Henry 1989b: 149f.). The author proposes that the differences between lowland and highland occupations can be explained by a general change in *mobility strategy*. While the total character of occupation in the highlands suggests a more 'residential' mode of settlement (*sensu* Binford 1980) where human presence was essentially "mapped onto resources" (*ibid*: 150), the nature of human settlement in the lowlands instead points to a 'logistical' strategy placing more emphasis on the portability of lithic materials and hence favouring the import of laminar blanks from the highlands. Henry thus closes the 'transhumant' settlement system by illustrating the functional complementarity of highland and lowland occupations and the flow of lithic material between them.

The author takes his results as an opportunity to criticise overly simplistic 'distance-decay models' of raw material economisation. He argues that such models, by predicting a close link between the size of artefacts and the distance to potent raw material sources, fail to take into account that human groups sometimes impose strong metric constraints onto certain tools (cf. Henry 1989b: 153) – constraints that are probably more 'cultural' than 'situational.' In such a situation for which he regards his Epipalaeolithic case study as an example (*ibid*.: 149; cf. Henry 1973; Marks 1976; Bar-Yosef 1981), alternative means for economisation must be employed. The case of the highland sites is taken to indicate that such an alternative strategy may consist in "advancing the reduction stream or manufacturing process closer to the finished implement when near raw material sources" (Henry 1989b: 153). This shows that reduction behaviour can be *economic* even if it does not follow a 'distance-decay' pattern – 'economisation' is often achieved by spatially segregating lithic reduction which, as a consequence, provides general information about the organisation of the adopted settlement system(s).

Overall, *Correlations* treats lithic technology as a 'derived' phenomenon. It is seen as a product of human ecology.[428] As such, lithic technology primarily affords a means to cope with particular environments, in particular the uneven and often patchy distribution of resources therein. This results in a well-defined *chain of determination* guiding argumentation and explanation. The base of the chain is built by the physical environment and its resource potential.[429] Henry (1989a) effectively uses topography, i.e., elevation belts, as a proxy for changing ecological conditions and resource availability. Human groups have to adjust their behaviour relative to this basal environmental structure if they wish to survive. Mobility provides a flexible strategic means of doing so. Thus, settlement systems can be viewed as a systematisation of implemented mobility solutions. Lithic technology, then, has to support these specific mobility strategies and variation in these strategies, conversely, bring forth different requirements for lithic technology. Just as Darwin (1859: 90) proclaimed an 'economy of nature' to understand the evolution of life, lithic technology is identified as a locus of 'human economy' to understand human ecology. This is why technological signatures can be used to infer the working principles of particular settlement systems. Varying lithic reduction signatures are interpreted as the outcome of the specific intersection of human mobility and human ecology (cf. e.g., Henry 1987, 1995; Kelly 1988; Nelson 1991; Kuhn 1995; Kuhn et al. 2016; Cicero 2017).[430] The reconstruction illustrates that reality is compartmentalised and the different compartments are regarded to constraint each other in a largely predefined manner. The physical environment is always more foundational than human mobility, and

tween 'lowland' and 'highland,' this node, understood as a *cause*, must be a highland site. The best explanation of the discrepancy is thus that there is a flow of objects between different elevations. [See also Henry (1989b: 149) for an additional metric argument why import is the most parsimonious explanation]

[428] See esp. Henry (1995: 1-6); cf. Henry (1982, 1986, 1987).

[429] Cf. Henry et al. (2017) for a more recent expression of the same research configuration.

[430] This is a general theme in Anglophone lithic research. Patterns of lithic technology are often interpreted from the perspective of mobility – a preoccupation that Kuhn et al. (2016: 86f.) have termed the 'human movement ecology paradigm'. This paradigm can be traced back to Binford's (1978, 1980) influential ethnoarchaeological work with the *Nunamiut* of Northwestern Alaska and the related recognition that hominin mobility needs to be studied beyond 'sedentism' and 'nomadism' (Kelly 1992; cf. Kuhn et al. 2016: 92). Binford's (1980) distinction between 'residential' and 'logistic' modes of mobility was an attempt to address this issue (cf. Ambrose and Lorentz 1990; Grove 2008, 2010). Inspired by the foundational work of Kelly (1983, 1995) and others, mobility became quickly the socket of studying human *strategic behaviour* in general. Research within this paradigm can be decomposed into three different strands of lithic inquiry: (a) *Technological Organization* (cf. Shott 1986; Bamforth 1991; Neslon 1991; Carr and Bradbury 2011; McCall 2015); (b) *Human Behavioural Ecology* (HBE) (cf. McCall 2007; Shea 2011b, 2017a; Kelly 2013); and (c) *Optimal Foraging Theory* (cf. Winterhalder 1981; Bleed 1986; Bousman 1993; Winterhalder and Smith 2000). All three approaches show considerable conceptual overlap and explicitly examine lithic technology in its wider ecological framing.

human mobility is always more basal than lithic technology. The 'chain of determination' therefore authors a clear-cut *direction of determination*, so that the more basic rungs of reality constitute the more derived levels. With Pepper (1942), we can say: the more basic the compartment, the more 'effective' its categories. The underlying logic of reasoning is mechanistic. Not only entails the structure of reality *causal hierarchies*, the world is generally viewed as a *strongly determined place*. Henry's (1989b) approach is clearly based on 'hard ecology'[431] and takes up a theme that has traditionally experienced considerable attention in Anglophone Palaeolithic archaeology: human-environment adjustments (e.g., Butzer 1964 [1971], 1982, 1986; Butzer and Isaac 1975; Binford 2001; Braun et al. 2008a; Petraglia et al. 2009b; Barker 2017). Even though we will return to this issue in more detail at the end of this chapter, it is already clear from Henry's (1989b) account that reasoning on the role and status of lithic technology is guided and corroborated by a theory of *causal adjustment*. Technological signatures are considered 'specific responses made by an organism on the stimulus of specific environmental configurations' (Pepper 1942: 226).

The advanced explanation reflects the *principle of heteronomy*,[432] i.e., the mechanistic certainty that each phenomenon must be explained in terms of another phenomenon, preferably a 'less derived' one. Explanation, in other words, is firmly grounded in the *specificity of external relatedness*. These externally related phenomena are seen as the parts of a worldly whole; they can be graded somewhere between the 'primary' and 'secondary' categories of reality. However, in contrast to the role of correlation in the 'formistic' endeavour of explanation, correlations in mechanism are never explanatory *ipso facto*, but are typically used to identify potential pairs of 'effective' and 'ineffective' categories. The detection of correlations thus facilitates the identification of *causally coupled* sections of reality. The twist is that these correlations, if they tell us something meaningful about reality, must be *predictable* in an unequivocal and highly detailed manner, and not merely in terms of structural similarities. From a mechanistic point of view, to explain a given domain of reality – in Henry's case lithic technology – means to show that its observable features follow by necessity from the constitution of the relevant interfacing domains of reality.[433]

These expositions should be sufficient to demonstrate that *Correlations* furnishes a mechanistic perspective on the lithic record. The analysis has revealed that two mechanistic systems of lithic technological organisation can be distinguished. The first is the reduction system itself, with its 'stream' of raw material diminution; the scale of this working system is the individual assemblage. The second system is the settlement system in which multiple localised reduction systems take parts; here, the scale of observation is a structured landscape. Both of these system, as we have seen, bring forth their own 'field of locations' – local reduction systems may in fact be recognised as the discrete locations of their larger settlement system – and each is characterised by specific 'primary laws.' With Bunge (2013), these systems can be understood as 'concrete' and structured composite entities. Each of them has one or more mechanisms or characteristic processes which determine their observable character. A 'concrete' systems in Bunge's sense can be defined by the ordered quadruple *composition-environment-structure-mechanism* (*ibid*.: 590). Clearly, this conception is consistent with Henry's (1989b) account and tightly situates *Correlations* in the realm of mechanistic approaches.

---

[431] Ecological thought has traditionally supported two species of approaches: 'hard' and 'soft' ecology. The division is well-documented in a number of scientific disciplines but has received some notable attention especially in environmental ethics (cf. Shrader-Frechette 1995). 'Soft ecology' approaches emphasise relational thinking and tend to be qualitative and general. The corresponding scientific attitude is 'interpretive' and 'understanding-based' (cf. Chapter 3). 'Hard ecology,' by contrast, seeks to be precise and predictive and stresses the importance of quantitative reasoning. It generally attempts to unearth second- or higher-order principles of ecological functioning, its science is 'explanatory,' and its explanations tend to be *subsumptive*, i.e., subsume the particular under the general. An example of a prototypical hard ecology approach anchored in 'hypothetico-deductive' reasoning is provided by Peters (1991). In general, soft ecology often relies on qualitative concepts such as 'ecosystem' which hard ecologists find difficult to operationalise. As Shrader-Frechette (1995: 126) puts it, soft ecology perspectives tend to *underestimate certainty* and may thus often demand too little from ecology, whereas hard ecology probably *overestimates certainty* and may thus frequently demand too much from ecology. This difference resonates with diverging conceptions of the structure of reality which place different emphasis on determinateness and the strength thereof (cf. Chapter 2).

[432] Heteronomy is the dogma that the existence and development of phenomena is *fully dependent on factors external to these phenomena*. In 'mechanism,' this seeded character of reality is interpreted in terms of external causal constitution. The resulting causal structure presupposes a *hierarchy* of observable qualities of reality.

[433] Cf. "Integrating technological studies into archaeology's mission within paleoanthropology, namely to document and explain evolutionary change in human behavior, inevitably leads beyond the confines of technology itself. In order to bring technological data to bear on major changes in human adaptations, it is essential to explore how toolmaking was related to hominin subsistence and foraging ecology." (Kuhn 2014 [1995]: 16)

4.2.2 *Dibble's scraper reduction model*

The second window into mechanistic approaches within Anglophone lithic research is opened by the study of general 'reduction effects,' the investigation of artefact 'biographies' and 'transformational histories,' as well as various themes of 'reduction economy.' These inquiries pursue two interrelated goals: on the one hand, they seek to better understand the *physical-mechanical ramifications* of lithic reduction; on the other hand, they hope to shed new light on the significance of classic concepts such as 'form' and 'typology,' often in the context of ecology- and mobility-oriented studies or the broader endeavour to chart strategic behaviour in human evolution. The first objective is often linked to the ambition of reconfiguring the interpretive space of lithic analysis and to offer more 'basic' or 'foundational' explanations of the evidence than typically provided (McPherron 1994: 29; cf. Jelinek 1976). The second aim encapsulates a similarly mechanistic attitude; the ambition is to demonstrate that categories of 'form' and 'type,' although doubtlessly being detectable in the empirical world, must be treated with great caution:

> "In large part the debate over reduction strategies, reduction intensity and typological variability revolve around the reality of types. If one's perspective on the types is that they represent real or natural divisions in artifact variability, then it is natural to view lithic reduction strategies as geared towards the production of these various types. If, on the other hand, one's perspective on the types is that they represent arbitrarily imposed subdivisions in continuous variability, then it is natural to view them as stages of a single reduction strategy. [...] Neither Bordes, Roe or anyone else has ever established that the Acheulian biface types are anything other than arbitrary divisions of continuous variability [...]." (McPherron 1994: 38)

'Form' or 'type' categories are considered to trace 'appearances' and to be indicative of 'reality' only if the elementary processes that bring them into being have been identified and described.[434] The key issue here is the problem of *equifinality*, i.e., the circumstance that different processes may produce similar or even the same forms and types.[435] Both ambitions register the fundamental mechanistic trouble of policing the problem of *Appearance and Reality* (cf. Chapter 2). The status of the 'phenomenal' realm – i.e., what is observationally given – is deeply ambivalent for a mechanist: although the observational paves the only conceivable and reliable way to knowledge about what actually is, observable patterns may easily seduce the analyst and draw her/his attention away from the 'true' structure of reality.

Technologies of reduction have traditionally been of interest to lithic scholars examining the interface between economy and mobility (e.g., Kelly 1988; Kuhn 1992, 1995). A central reason is that aspects such as an object's 'use life,' 'reduction intensity,' and 'trajectory of reduction' promise to inform directly about object-mobility and economising behaviours of the object-users. Binford's (1979) distinction between 'expedient' and 'curated' technologies, later refined by Nelson (1991: 63-65), was intended to answer similar questions. 'Curated' objects, that is, highly reduced, re-sharpened, and/or re-cycled lithic elements, are generally thought to reflect 'mobile' items that have the potential to be carried around over considerable timespans and geographic distances (cf. Marks 1988); 'curated' technologies help to conserve raw material and thus deflect problems of raw material supply and predictability which may arise in settings of high group mobility (cf. Bamforth 1986; Kuhn 1992). 'Expedient' objects, by contrast, indicate situational on-spot solutions, lower degrees of mobility, reduced planning, and may entail *ad hoc* strategies of tool-utilisation (Nelson 1991: 64-66). As Nelson (1991: 65) correctly notes, however, 'opportunistic' and 'unanticipated' behaviours must strictly be distinguished from 'expedient' behaviour since the latter is often a regular and integral element of the overall set of strategies employed to meet particular situations and conditions. Although the dichotomisation between 'expedient' and 'curated' has been criticised as too simplistic (e.g., Nahler 1991) and it is clear now that one needs to take into account the entire gradient of more or less curated and more or less

---

[434] Again, this is where 'mechanism' and 'formism' tend to disagree strongly, for 'formism' takes the *form* in 'concrete existence' as its point of departure. Within American Palaeolithic archaeology, this coordinate of conflict is for example illustrated by the heated discussion between Angela Close (1991a, 1991b) and Harold Dibble (1991c) on the interpretive significance of lithic types.
[435] 'Equifinality' is usually referred to as the principle that 'a given end state can be reached by many potential means' (Mayhew 2015). In geomorphology, for example, the concept indicates that similar landforms may have been brought into existence by different sets of processes. In a notable study of geomorphic equifinality, Cruslock et al. (2010) have demonstrated that two different erosional processes – wave action and ice scour – result in highly similar erosional products and meso-scale landforms in structurally comparable lithological settings. Landforms alone, therefore, are not unequivocal proxies of the causal factors involved in their geomorphic genesis.

expedient technologies (Shott 1986; Nelson 1991), qua *theoretical distinction* it remains a valuable distinction and enables the formulation of precise predictions and test implications to guide future research (cf. Dibble et al. 2016: 827).

Generally speaking, the study of reduction intensities and economies – that is, to answer the question: how much material is missing? (e.g., Barton 1988; Kuhn 1990; Eren et al. 2005; Shott 2005b; Marwick 2008b; Iovita 2008) – is viewed to elucidate the functioning of a mobility system in a particular environmental setting. Object transformation and reduction are the inevitable consequence of task-specificity, the working principles of the attendant settlement system, and the present natural environmental conditions including raw material quality and availability (e.g., Kuhn 1994). Thus, knowledge on lithic technology is gained and secured by *causally adjusting* the reduction patterns to these ecological parameters (cf. Jochim 1976; Binford 1980; Kelly 1988; Rolland and Dibble 1990; Kuhn 1993; 2014 [1995]). This explanatory strategy is not only 'integrative' because factors of raw material consumption take over a privileged position in reconstructing hominin behaviour, but also because the structure of ecological constraints yields a specific mechanism of explanation:[436]

> Put another way, since systems of adaptation are energy-capturing systems, the strategies that they employ must bear some relationship to the energy or, more important, the entrophy structure of the environments in which they seek energy. We may expect some redundancy in the technology or means, as well as the organization (labor organization), of production to arise as a result of "natural selection." That is the historical movement toward an "optima" for the setting. Put another way, technology, in both its "tools" sense as well as the "labor" sense, is invented and reorganized by men to solve certain problems presented by the energy-entrophy structure of the environment in which they seek to gain a livelihood." (Binford 1980: 13)

What Binford describes in this short passage is nothing else than an ecological *equilibrium system* in which the respective elements, including reduction economies, are structurally adjusted to one another. The mechanistic orientation of this type of reasoning should be obvious.

Can this mechanistic signature be retraced in more specific instances of Anglophone lithic inquiry? Without any doubt, the best-known model of lithic reduction and artefact 'use histories' has been proposed in a series of influential papers by Harold Dibble (1984, 1987, 1988, 1995b). His 'scraper reduction model' was introduced to explain typological patterns in the French Mousterian and delivered an important argument in the aftermath of the 'Binford-Bordes debate.' The model has variously been identified with the 'reduction argument' (Kuhn (2014 [1995]: 15f.). The reduction argument holds that artefact *form* – i.e., shape- and morphology-based characteristics – change in the course of raw material attrition. It draws from older ideas (Cooper 1954; Frison 1968), especially on what is now widely known as the 'Frison effect' (after Jelinek 1976) and applies them to the variability of scraper types in the French Mousterian arguing that these types embody *transformational phases*, rather than 'functional' or 'cultural' markers. Already on a general level, Dibble's approach thus testifies to a mechanistic critique of purportedly 'static,' 'fixed' and overly 'eternalised' categories of concrete reality.[437] Even though its central argument of course challenges Binford and Binford's (1966; cf. Freeman 1966) take on typological variability, it shares the 'Binfordian' conviction that the essentially 'static record' of the past needs to be explained by the 'dynamic processes' that created it. The static record itself, therefore, is the gateway to proper knowledge, yet cannot be taken at face value (cf. Binford 1972, 1977, 1981b: 25).[438] Binford (1981b: 26) himself explicitly noted that the gulf between 'static' evidence and 'dynamic' explanation may best be bridged by invoking *causal relationships* and *general principles of necessity*. The categorical distinction between 'static-ness' and 'dynamic-ness' thereby justifies the

---

[436] A general goal here is to achieve high-resolution, target-sensitive explanations and to disentangle the various causes underlying the formation of a given lithic assemblage: "[i]solating evidence diverse economic roles in lithic assemblages is not just a matter of measuring variation, of recognizing that some artifacts were completely used up while others had very short lives, or that some tools were moved long distances and others produced on site. We expect a certain degree of variability within any assemblage created by mobile toolmakers, especially when that assemblage accumulated over a long period of time, under varying conditions. What is more significant is the partitioning of variation, the degree of independence among artifact life history trajectories. Convincing evidence that artifacts reflected differing social or economic roles would come only from consistent associations between artifact forms, resharpening/maintenance, and perhaps raw material selection." (Kuhn 2011: 103)

[437] Cf. esp. Dibble et al. (2017: 817-825).

[438] Kelly (2016: 17) similarly notes in his chapter *How Archaeologists Think*: "[i]n a textbook, we might write a chapter describing "what happened" during Basketmaker times, a description of the people's subsistence and their social and political organization as we interpret it from material remains. Another chapter would use the material remains of Pueblo I sites to relate how subsistence and social and political life changed from Basketmaker times. This is not easy, yet breathing life into material remains is what archaeology is all about – going from the static remains of the past to the dynamic behavior that produced them."

conceptual separation between 'theory' and 'data' (cf. Chapter 3) and identifies the problem of *Appearance and Reality* (cf. Pepper 1942: 145; see *supra*) as a key venue in the epistemology of Palaeolithic archaeology. As McPherron (2006: 268) puts it, one may then "explicitly use typology to reconstruct process." Evidently, this research orientation draws heavily on mechanism:

> "In the long run, the most significant contribution of the "reduction argument" has been to focus attention on the "life histories" of tools. Viewing artifacts as the end product of a long dynamic process of manufacture, use, and renewal – rather than as fossilized conceptual blueprints – has helped to divert research in a very productive direction, one which is much more in keeping with other developments in Paleolithic studies." (Kuhn 2014 [1995]: 16)

The initial reduction argument of the 1980s has gradually evolved into a full-fledged 'Reduction Thesis' (e.g., Potts 1991; McPherron 1994; Dibble 1995b; Chase et al. 2009; Braun et al. 2009; Dibble et al. 2017: 827). This thesis provocatively asserts that patterned categories of lithic 'form' are likely to reflect arbitrary stages, steps or grades on a continuum of reduction whose causal-determinative coercion has to be identified in each individual case (cf. Marwick 2008a: 108, 112f.):

> "[…] It is important to note here that the use of the word "stage" in the context of the reduction strategy does not imply that these stages were somehow recognized by the makers of these artifacts. The word stage is substituted for the word type only to emphasize the connection between them and the idea of a single process. Still, the stages, like the types, are completely arbitrary constructs, and there is absolutely no intention to argue that these stages correspond to actual stages that may have been recognized by the makers of the artifacts (cf. Newcomer 1971). They are simply a heuristic device and no more." (McPherron 1994: 38)

The 'Reduction Thesis' has since been applied to a number of case studies in the Palaeolithic and Epipalaeolithic of the Old World. Examples are the Oldowan (Potts 1991; Braun et al. 2009), Acheulean handaxes (McPherron 1994, 1999, 2000; Iovita and McPherron 2011), the Middle Palaeolithic (Barton 1990; Holdaway et al. 1996; Iovita 2008); the African Aterian (Iovita 2011); the Western European Aurignacian (Blades 2003), and the Near Eastern Epipalaeolithic (Olszewski 1993, 2016; Neeley and Barton 1990). All of these studies challenge the overall stability of lithic reduction sequences. They promote a view of lithic reduction that highlights the *fluidity*, *continuity*, and *flexibility* of both the knapping process and the management and use of different knapping products (cf. Dibble et al. 2017: 827f.). A curious epistemological ramification of this conception seems to be the status of lithic reduction somewhere between natural (*n-transformation*) and cultural (*c-transformation*) processes of transformation.[439] The research programme supplied by the 'Reduction Thesis' specifically interrogates whether lithic reduction trajectories can be explained by non-human or system-internal factors alone, or whether at least some cultural input needs to be assumed even if some details of the reduction sequence are comprehensible in natural terms (cf. Baumler and Speth 1993). The 'Reduction Thesis' thus puts a counterweight on what it perceives as the dominant 'idiographic' view of lithic technology, at least balancing the tides between 'idiographic' and 'nomothetic' explanations in lithic analysis.[440] In line with their insistence on 'low-level' explanations (see *supra*), proponents of the 'Reduction Thesis' want to demonstrate that basic principles of the reductive process are sufficient to account for much of the encountered intra- and inter-assemblage variability. These processes are as 'natural' as they are 'anthropogenic.'

Dibble's 'scraper reduction model' (1984, 1987, 1988, 1995b) posits that the main recognisable scraper types of the French Mousterian represent *metastable states* of a dynamic, yet generally continuous and unified reduction system. The scraper 'types' are argued to reflect recurrently instantiated *stations* on a well-defined trajectory of reduction (cf. Dibble 1995b: 318f.). While this overall trajectory

[439] For the distinction between *n-transformation* and *c-transformation* within general 'formation theory,' see Schiffer (1976: 1-3; cf. Bernbeck 1997: 67-81).

[440] The duality between 'idiographic' and 'nomothetic' science was introduced by New-Kantian philosopher Wilhelm Windelband (cf. Thomae 1999). In his *Geschichte und Naturwissenschaft* (1904 [1894]), Windelband defined 'nomothetic' as the tendency to generalise in and to derive laws in an effort to explain types or other 'objective' categories of reality. A 'nomothetic' approach, according to him, is more common in the natural sciences [*Naturwissenschaften*]. 'Idiographic,' by contrast, was defined as the tendency to specify and to seek understanding of meaning and contingency which often results in an emphasis of uniqueness and the subjectivity of phenomena. Windelband attributes this research orientation primarily to the humanities [*Geisteswissenschaften*]. More recently, the term 'nomothetic' is sometimes also used to designate approaches that focus on *inter-individual* variation (i.e., variation between parts), whereas 'idiographic' serves to describe approaches that concentrate on *intra-individual* variation (i.e., variation within wholes) (cf. Beltz et al. 2016). In archaeology, 'nomothetic' approaches are often associated with processual archaeologies insofar as they employ Hempelian hypothetico-deductive schemes of reasoning (cf. Bernbeck 1997: 68; Chapter 2, 3).

may tell us something about the behaviour and culture of its Neanderthal authors, the types themselves are explicable in terms the 'primary laws' and regularities of sustained raw material attrition. Mechanical processes of lithic ablation and attrition, in other words, are regarded to have specific *typological consequences*. Typology, therefore, is not – as usually in 'formism' – the input variable but is rather identified as the *inevitable output* of not directly observable reduction processes. Typology becomes a category that captures the 'specifity of response' of the processual constitution of lithic reality. As a result, typology can only be convincingly explained if its patterns can be unequivocally linked to different process-specific effects. Dibble's (1987: Figure 4) reconstruction of the specific sequence of scraper attrition, illustrated as a sequence of typological scraper states, reflects this mechanistic logic (**Fig. 17**). Dibble (*ibid.*: 116) specifically contents that the different scraper types illustrate different phases of the potential use-life of scrapers. He argues that 'single scrapers' constitute the natural point of departure and thus the first 'stage' of scraper attrition; they are gradually transformed into various variants – in 'formistic' terminology 'sub-types' – of 'double scrapers' or, alternatively, may result directly in different types of 'transverse' or '*déjeté* scrapers'; 'double scrapers,' however, may further wear down into various kinds of 'convergent scrapers.' On a more general plane, Dibble (1995b: 319) distinguishes between two theoretically independent sequences of scraper reduction: the single-double-convergent and the single-transverse (*déjeté*) sequence. Which pathway of scraper transformation is taken primarily depends on whether or not additional edges are retouched in the course of a scraper's use-life.

Three features of Dibble's argumentation are important to highlight here. The first is that specific interdependencies between scraper morphologies and the location and intensity of edge modifications or attritions are outlined (cf. Dibble 1987: Figure 2, 1995b: Fig. 9; **Fig. 18**). These interdependencies can be described and modelled in mathematical language (Dibble 1995b: 319f., Fig. 10). This means that the various effects of scraper attrition become predictable. Specific actions and processes are linked to a specific morphological outcome by means of a principle of determination – a *cause* in the broader sense of the term is introduced. Thus, in order to corroborate the relevant interdependencies, one simply needs to *causally adjust* the relevant parameters. The second point is that these relationships are valid independently of hominin intervention, but they provide us with valuable clues as to *when* hominin interference is most likely to occur and *how* it can be evidenced. While the processes of raw material attrition themselves are purely *mechanical*, hominins of course need to 'allow' further attrition to occur and are 'in command' of certain aspects of reduction. They for example have to *decide* whether or not they wish to add a second working edge by incipient modification or use. The 'scraper reduction model' thus helps separating between different sources of typological scraper variability. Based on these considerations, one may even suggest that the single-double-convergent trajectory involves more hominin agency than the single-transversal sequence of scraper reduction. At any rate, the model elucidates that only a relatively low degree of hominin interference seems necessary to explain the observable variability of Mousterian scraper tools. The third feature that requires some attention is the precise nature of the scraper 'types' themselves. In this context, it is notable that Dibble (1995b: 318) aggregates various typologically distinct kinds of scrapers into broader categories – i.e., 'single scrapers' which are only retouched along one edge, 'double scrapers' with two laterally retouched edges, 'convergent scrapers' with two laterally retouched edges converging at one end, and 'transversal scrapers' with a single broad edge located at the distal end of the blank. Minor scraper classes are discarded from the analysis because they are considered to represent background noise or non-stable points on the reduction continuum, for example as products of idiosyncratic behaviour, random sources of variation, or non-sustained tool-utilisation (cf. Dibble 1995b: 332f.). This fact alone bespeaks of an 'integrative' attitude of explanation. More important, however, is the circumstance that the aggregated main scraper types are strongly *theory-informed*; they are deliberately 'theory-laden,' one might say. The reason, of course, is that mechanism can only accept form-based categories of reality if they turn out to be *instrumental* for the advanced mechanistic explanation. The scraper types, in other words, serve the adopted higher-level theory of reduction and attest the *causal adjustment* between the categories of 'appearance' (i.e., types, classes) and the categories of 'reality' (i.e., processes, causes, laws). By being 'effective' categories in this sense, the reality of these types is exposed and they can be treated as the active parts of the reduction machinery and its specific 'field of locations.' Importantly, the types can therefore be identified as the 'effective' categories of mechanism.[441]

The reduction process underlying the formation of the four main scraper types of the French Mousterian can now be understood in complete mechanistic terms. That Dibble (1995b: 318f.) calls attention to the four types as points on a continuum of reduction simply expresses the fact that they occupy different 'positions' in their 'field of locations' – a field which is propelled by a least one 'primary law' of reduction. This law comprises the subtractive effects of ongoing lithic reduction (e.g., modification, attrition, re-sharpening) and the specific mechanical relationships that were identified between the four groups of scrapers.[442] These relationships also specify the effective 'primary qualities' that power the reduction machine and lead to the predictable outcomes. The types are thus nothing else than idealised *events* which, by virtue of their 'location' in the field structure of reduction (cf. Pepper 1942: 191f.), are *causally enchained* in a specific order. The reality of the types and their significance is confirmed by the fact that they occupy this well-defined and *necessary* place in the total reduction machinery. The circumstance that the scraper types are effectively interpreted as *metastable states* – as 'foci of instantiation' if you will (see *supra*) – further indicates that the reductive machinery is conceptualised here as a fully integrated 'field structure' in which almost no residual discreteness is left.[443] The types simply denote the locations of the field where the *potentialities of material instantiation* are highest. This view is supported by the particular fashion in which noise and minor scraper classes are explained away (see *supra*). It also explains the still problematic nature of 'types' and their lurking status as *epiphenomena.*[444] With Pepper (1942: 212-220), we can conclude that, overall, Dibble's 'scraper reduction model' provides a prototypical example of a 'consolidated' variant of mechanism: the empirical lithic world is apprehended by the non-observable *singularity* of a structured and causally-imbued field. An implication is that the behaviour of lithic reduction systems is defined by analogy to the behaviour of already known field structures (e.g., electromagnetic field, quantum field). From this perspective, reduction systems come into view as spatiotemporal wholes with a unified reduction *geometry*.[445]

The preferred mode of visualising such a fully determined reduction system is the *flowchart* or even more basic *digraphs* (cf. Harary et al. 1965). These graph types enable the *formal* representation of constitutive relationships within a spatiotemporal matrix. They draw to varying degrees on 'graph theory' (e.g., Bondy and Murty 1976) and are therefore well-suited to depict dependent and independent causality and directed cascades of causation. In theory, they should also allow the representation of metastable states and subordinate conditions – in short, to capture the potential hierarchies within a mechanistic reduction system. Because digraphs may be constructed with the help of mathematical equations, graph conjectures may even be directly tested against the available data (cf. Bang-Jensen and Gutin 2007). A 'digraph' or *directed graph* is a simplification of a causal system but retains its cardinal characteristics. In the case of lithic analysis, reduction systems can be visualised as pure 'fields of locations.' Each node or junction of the graph stands for an 'event' or quasi-stable state, each

---

441 See Chapter 2: esp. **Box 7**.

442 It is no coincidence that the 'Frison effect' (Jelinek 1976; Frison 1968) is regularly invoked here as fundamental principle of lithic reduction. Arguably therefore, the 'Frison effect' can be interpreted as a 'primary law' of lithic reduction (cf. esp. Dibble 1981: 7f., 1984: 435, 1995b: 299-306, 355; McPherron 1994: 175; Dibble et al. 2017: 819).

443 'Metastability' is a property of a dynamic system that seeks to explain the emergence of what can be called pseudo-discreteness on an entirely unified substrate. Typically, phenomena of metastability refer to the existence of two or more timescales on which the system under consideration exhibits very different behaviours (cf. Bovier 2009: 178). The concept therefore helps to understand the issue of *transition* between timescales and system-behaviours. On shorter timescales, dynamic systems tend to quickly reach some sort of equilibrium state and the kind of equilibrium will depend on the initial conditions. On longer timescales, however, one occasionally observes transitions between multiple of equilibrium states; each timescale, if you will, has its proper equilibrium state. These equilibria are only stable at the metalevel and a set of new system-internal stimuli may cause another transition. The point is that metastable states essentially describe *statistical realities*. The analogy of the 'metastable state' allows one to understand why some states are recurrently instantiated while others are not – the latter seem to delineate non-stable, transitional states. It therefore provides a means to grasp how non-discrete processes can produce 'pseudo-discrete' outcomes.

444 In other words, the possibility to explain the occurrence of certain lithic types by calling upon the heterogeneous potentiality of a unified field-structure solves the problem of types being both 'real' and 'unreal' at the same time. Types are real because they explain how the reduction machine is powered, yet they are unreal because they represent a derived category of existence – one simply cannot deny their status as 'appearances.' By invoking specific field structures and their causal-determinative principles, it becomes possible to elucidate the specific empirical qualities of types 'bottom-up' without fully explaining them away. This cognitive strategy to overcome the problem of *Appearance and Reality* is characteristic for 'consolidate' versions of 'mechanism.'

445 Cf. Pepper (1942: 212f.) for a detailed explanation of the notion of 'geometry' in the context of 'consolidated mechanisms.'

of which is connected to at least one other element of the graph by some determinative principle. Such graphs can thus coevally capture the precise 'location' of the 'working' parts of the reduction machine, the overall configuration of the 'field structure,' and the principles of causal integration. It is no surprise, then, that Dibble (1987: Figure 4) also conveys his application of the 'Reduction Thesis' to Mousterian scraper technology as a compact 'digraph' (cf. **Fig. 17**). Other well-known applications of the 'Reduction Thesis' have followed his lead and employ similar imagery. For example, Neeley and Barton (1994: Figure 6, 8; **Fig. 19, 20**) use simple digraphs to illustrate the reduction pathways of Epipalaeolithic microliths. Potts' (1991: Figure 1; **Fig. 20**) reconstruction of the Oldowan reduction continuum also makes use of this type of imagery. It is important to note that all of these images theorise non-equivocal relationships between different reduction nodes; these links, represented by two or more directed arrows impinging on a single node, specify the *equifinality* of systemic functioning (cf. Kuhn 2014 [1995]: Figure 4.9, 4.11). This point is important since only mechanism interprets 'equifinality' in this particular manner, as the problem of different processes producing broadly the same results. The issue of 'equifinality' can therefore only be solved if the relevant system-states are mapped onto their 'field of locations' and the associated 'primary' and 'secondary laws' that hold this field together are outlined. 'Digraphs' and flowcharts in Anglophone lithic research serve this function. They are therefore *explanatory* devices in their own right, but according to the specific mechanistic understanding of this concept.[446]

The general mechanistic orientation of approaches that deploy the reduction argument is not least reflected in Dibble's (1995b) summary of his broader survey of reduction dynamics in different Lower and Middle Palaeolithic contexts:

> "But these convergences [in artefact form during the Middle Palaeolithic] have broader implications than just the fact that we are able to classify the tools into the same typological framework. First, it is surprising that such similarities occur throughout the range of Lower and Middle Paleolithic industries. Second, not only do the same types occur, but they exhibit the same sorts of relationships between them. These facts point to a very fundamental explanation of tool variability. Processes like those proposed for scraper reduction have already been witnessed ethnographically, and they have been proposed for virtually all periods of human prehistory. Thus, they are real and represent the kind of low level explanation that can crosscut both stylistic and functional considerations. Given that the patterns of Middle Paleolithic tools are so consistent with the predictions of these models, it would seem that a reduction argument is the simpl[e]st explanation that can account for the data presently available." (*ibid.*: 357f.)

How can one be sure, in general, that these interdependencies between pattern and process hold true in general? In other words, how can we know their *universality*? A possible mechanistic answer would be: by means of controlled experimentation. The 'Philadelphia school' of lithic research would plausibly provide a very similar answer. Not only are the descendants of this school responsible for establishing seminal experimental research programmes all over the Anglophone research sphere, controlled experimentation has already played a key role in the formulation of the 'Reduction Thesis' itself. In general, lithic experiments are designed to bridge 'theory' and 'data,' as well as to assist in the construction of general reduction models and to verify them through direct observation (cf. Shott et al. 2000; Dibble and Rezek 2009; Lin et al. 2017).[447] They have a two-fold purpose: on the one hand, they help to isolate potential causal factors, determinative principles, and 'laws of reduction' which might have given shape to varying reduction phenomena; on the other hand, they enable to investigate under laboratory conditions how these factors interact with one another and what the results of these interactions are. The subsequent comparison of experimentally attested regularities with empirical patterns in real lithic assemblages is a classic mechanistic signature. Dibble's own doctoral dissertation *Technological Strategies of Stone Tool Production at Tabun Cave* (1981), for instance, has adopted this research strategy.

Experimental reasoning also constitutes the epistemological backbone of the 'scraper reduction model.' The model rests on a number of key experimental studies that established a constitutive relationship between limited numbers of independent lithic variables. It is only through this experi-

[446] As the examination of lithic imagery in Chapter 3 shows, these images therefore form a somewhat original category of scientific visualisation. Their explanatory role, however, can only be understood if the 'mechanistic' categories are unpacked; they simply serve to satisfy the epistemological needs of 'mechanism,' especially if it seeks to reconstruct *causal systems*.

[447] See e.g. Speth (1981), Pelcin (1997), Davis and Shea (1998), Dibble et al. (2005), Eren et al. (2005, 2008), Rezek et al. (2011), Lin et al. (2013), Iovita et al. (2014) and Magnani et al. (2014) for a sample of ongoing work in the domain of controlled experimental lithic research.

mentally attested status of two or more variables being 'causally adjusted' to one another that they may assume a place as *key variables* of mechanistic reasoning. The reason is of course that mechanism is committed to an 'integrative' approach in which epistemic *relevance* and *irrelevance* delineate areas of inquiry themselves. A not unimportant aspect of mechanistic explanations, in other words, is to explain away part of the available evidence (cf. Chapter 2). Experimental research to a large degree consists of the analysis of *flake formation*, that is, how a flake is made (cf. Rezek et al. 2016).[448] It typically quantifies the mechanical aspects of this process (e.g., Speth 1972) and uses mechanised and automated equipment (e.g., hydraulically powered knapping robots) to achieve this goal (**Fig. 21**). Interestingly, this research design represents a direct *imitation* or, perhaps better, *implementation* of the mechanistic root metaphor – the causally operating 'machine.' It also testifies to the already noted proclivity of mechanism to place the foundations of lithic inquiry on maximally 'objective' grounds whereby 'objectivity' is opposed to human interference and subjectivity (cf. Chapter 3).[449] As Lin et al. (2017: [8]) readily admit, this type of experimental research thus requires 'uniformitarian' assumptions. Having said this, such experiments for example established a strong interdependency between length and width when artefacts are continuously reduced and thereby paved the way for the 'scraper reduction model' (Dibble 1988, 1991a). Equally important was the discovery that surface and platform area of lithic artefacts appear to be systematically correlated and that the respective ratio can be understood as a relative measure for original blank size (Dibble and Whittaker 1981; Dibble and Pelcin 1995). This knowledge about original blank size is invaluable and enables the precise determination of reduction intensity since the 'missing' material can easily be calculated by subtracting the encountered blank size from the original blank size. Other cardinal experimental findings, for instance the patterned covariation between surface area and thickness (Holdaway 1991) or the significance of exterior platform angle configurations for producing certain flake types (Dibble and Pelcin 1995), delivered crucial supportive arguments to feed the reduction argument.

Many of these basic findings serve to establish and refine the *test implications* of the argument (cf. Dibble 1984: 110; 1995b: 324-332). Experimental findings, in other words, enable scholars to *predict* certain regularities among the lithic variables and to assess whether these regularities support the available hypotheses. All three elementary relationships on which the original 'scraper reduction model' is based – i.e., (i) that retouch intensity is related to different scraper types; (ii) that retouch intensity corresponds to length-reduction; and (iii) that the more derived scraper types (convergent, transverse) have small surface areas but comparatively large platforms (cf. McPherron 1994: 175) – were established in an experimental setting.

The role of experimentation in this research context is thus complementary to the status of 'theory' in 'analytic' science (Lin et al. 2017: Fig. 1; cf. Chapter 3). We are now in a position to appreciate why. As shown by Dibble's approach and the role of controlled experiments in the construction of the 'scraper reduction model,' the employment of *experimental reasoning* is essentially an attempt to 'objectify' the 'context of discovery' which is typically discredited for its 'psychologised' and 'subjective' nature. By means of experimentally adjusting lithic variables and exploring the general space of variable interaction, correlations and relevant 'primary qualities' can be identified and discovered *before* primary data-analysis begins. Experimentation can thus fill the conceptual void between 'subjective' theory-creation and the 'objective' assessment of theory-derived test implications (cf. Chapter 3). Arguably, 'experimental reasoning' have already supplanted purely 'theoretical reasoning' in many branches of Anglophone lithic research because of this reason.

This 'experimental mode of inquiry' – an approach to experimental testing modelled on physics and other key experimental sciences – has its origin in the 'scientific turn' of the 1960s.[450] From

[448] It is possible to argue that experimental research in this tradition is an attempt to build a specialised 'formation theory' – a theory that is dedicated to explaining the fossilisation of lithic artefact properties under varying conditions (cf. Schick and Toth 1993, 2001; Shea and Klenck 1993; Barton and Riel-Salvatore 2014; McPherron et al. 2014; Kuhn and Clark 2015; Dibble et al. 2017: Fig. 4, 830-837).

[449] As already argued in some detail in Chapter 3, this 'objectivist' understanding of experimentation based on 'causality' and 'predictability' is not shared by French experimental research which relies more strongly on *personal insight* and an 'understanding-based' recognition of processes and technical relations. We can now appreciate the reason for this discrepancy: the Anglophone notion of experiment is modelled upon the *experimental sciences*, especially physics, and therefore tends to interpret the very concept of 'experiment' mechanistically.

[450] Eren et al. (2016) refer to this type of archaeology as 'hypothesis-driven' and regard the *replication* of lithic artefacts as a key feature of such an 'objective' and 'scientific' archaeology. 'Replication' is here considered to be synonymous with *prediction*. It engenders a mode of *explanation* proper to 'mechanism.'

early on, controlled experiments were seen as an indispensible ingredient of a truly 'scientific' approach to the Palaeolithic past. Unsurprisingly, experimental research thus quickly became an integral element of the multidisciplinary research architecture of Clark Howell and Desmond Clark's *Paleoanthropology* (1966) or Glynn Isaac's *Human Origins* (1989). This 'Berkeley era' was a significant historical moment not only because it marks the synergetic fusion of research traditions from the U.S. and the U.K. and hence the proper birthplace of a joint Anglophone research endeavour in Palaeolithic archaeology, but also because it cemented the status of experimental research as a basic pillar of inquiry in the study of human beginnings (cf. Isaac 1967; Schick and Toth 2001). The work of Kathy Schick (1986, 1987, 1997) and Nicolas Toth (1982, 1985, 1991, 1997) on lithic assemblage formation and the dynamics of tool-making are outstanding examples of this research trajectory (cf. Toth and Schick 1983; Reti 2016). Again, the central aspiration of these investigations was to illuminate the 'dynamic processes that are responsible for the observable patterns of an essentially static record' (*sensu* Binford 1972).

This guiding principle of the 'static' record and the 'dynamic' past, adopted by Binford and many others, is co-extensive with the classic mechanistic distinction between 'pattern' and 'process.'[451] As Binford (1981b: 25, 1983b) himself has made clear on several occasions, the corresponding figure of speech is more than just a "matter of talking," it entails an *epistemological thesis* – namely that the archaeological record has to be understood as a *contemporaneous phenomenon*.[452] This recognition cannot be overemphasised for its epistemological ramifications are tremendous. The first and perhaps most important consequence is that because the record is 'static' and its patterns only *observable* in the 'present,' we need to develop knowledge about general relationships between 'pattern' and 'process' in this present *before* we can competently advance to the 'dynamic' aspects of the Palaeolithic past. The major reason for this inferential detour is the particular mechanistic understanding of *equifinality* (see *supra*). Since similar patterns might be driven by vastly different processes, one cannot simply infer process from pattern. The implication is clear: 'abductive' reasoning has to be banished and 'inductive' inference becomes problematic. The only prospective answer to the problem is offered by an axiomatic reconfiguration of the discipline around the principles of 'actualism'/'presentism' (cf. Toth 1991; Rossignol 1992: 4; Schick and Toth 1993; Pobiner and Braun 2005; Toth and Schick 2001, 2009a; Pickering et al. 2009) and 'uniformitarianism' (cf. Cameron 1993: 43-54; Shea 2011c)[453]:

> "Among Binford's principal original contributions was his insistence that the correlations used to infer human behavior from archaeological data had to be based on the demonstration of a constant articulation of specific variables in a system. He argued that all analogies were inconclusive, whether they were based on worldwide evidence or were homologies drawn from the same cultural tradition as the archaeological data being interpreted. Instead, all behavioral explanations of archaeological material had to be based on a lawful demonstration that in the living (actual) world there was a constant correlation between a particular form of human behavior and a specific type of material culture." (Trigger 2007: 399f.)

Thus, the constitutive relationships that hold specific patterns and specific processes together under particular conditions must be assumed to convey *constants of reality* – otherwise there is no hope of ever gaining 'objective' knowledge about the past (e.g., Binford 1983b: 18). The target *universally* valid interdependencies, however, are not interpreted as abstract concepts or 'subsistent' categories, but rather as properties – 'regularities,' 'laws,' or 'principles of determination' – of the causally integrated spatiotemporal field we call planet earth. The presence and the past are connected by their participation in the same mechanistic machinery and this machinery, following Bunge (2013: 590), can be

[451] Cf. Chapter 2.
[452] Cf. "[...] It seems to me we must begin with certain fundamental statements of "being as such." *The archaeological record is a static contemporary phenomenon*." (Binford 1981b: 25; original emphasis)
[453] Following Cameron (1993: 43), I acknowledge that the notion of 'uniformitarianism' can be broken down into at least three variants, each of which may serve different epistemological purposes: *substantive uniformitarianism*, *methodological uniformitarianism*, and *associative uniformitarianism*. The 'substantive' variant argues that similar observations about the past and present can be correlated and explained by a constant rate or variable (e.g., the amount of C^{14} in the atmosphere); 'methodological' variants seek to derive general principles from the present correlations to guide inquiry into the past (*ibid*.: 42); and 'associative' uniformitarianism asserts that certain regularities in the association artefacts in the past must tell us something about the unobservable (and perhaps unique) behavioural and social processes of the past (*ibid*.: 43). With Pepper (1942), we can see that the first two variants serve the epistemological goals and principles of 'mechanism,' whereas *associative utilitarianism* tends to be summoned in 'formistic' approaches (see previous part of the chapter).

modelled as an ordered quadruple of *composition-environment-structure-mechanism*. Binford (1972: 106), for example, explicit called attention to the "interface between a living system and its field."

The central problem is always how one ought to deal with the disconnect between *Appearance and Reality*, a disconnect that is severely aggravated in the deep time context of Palaeolithic archaeology where not even the protagonists are invariable. At any rate, the entire suite of 'Middle Range Theory' (MRT) brought to bear by Binford and others, partly as a consequence of the interpretive impasse of the 'Binford-Bordes debate' (cf. Trigger 2007: 405-407), and its *ethnoarchaeological* research mandate can be understood as an attempt to deal with the difficult relationships between 'pattern' and 'process.' [454] The development of a generalised archaeological 'formation theory'[455] by eminent figures such as Brain (1967, 1981), Ascher (1968), Binford (1978, 1979, 1981a), Schiffer (1983, 1988), as well as Isaac (1976, 1981, 1989) and his students (e.g., Bunn et al. 1980; Bunn 1982, 2007; Kroll and Isaac 1984; Potts 1982, 1988; Blumenshine 1987; Pobiner and Blumenshine 1993; Kroll 1994) was motivated by the same problem (cf. Speth 2011: 134; Lucas 2012: 93-104).[456]

The question that was prompted by this research was of course what the most productive uniformity assumptions are and whether they may differ in varying contexts of application. Potts (1988), for instance, maintained that while early hominins clearly left patterns of 'butchering' debris in the archaeological record, the actual composition of the debris is often not even broadly analogous to butchering sites of present day hunter-gatherer groups; and that it may in fact well be that 'hunting' chimpanzees provide the better frame of reference in this case (cf. Cameron 1993: 44f.). Problems like this, however, only recalibrated the discourse and underlined that the search for the appropriate *frames of references* to reconstruct coupled systems of 'pattern' and 'process' was as important as doing 'actualistic' research (cf. Gowlett 1997, 2002, 2009; Binford 2001; Lycett et al. 2007; Toth and Schick 2009b; Shea 2017a, 2017b). The emergence of a 'primatological' branch of experimentation and field observation (e.g., Toth et al. 1993, 2006; Pickering and Wallis 1997; Plummer and Stanford 2000; White and Toth 2007; Pobiner et al. 2007) is a noteworthy example of the increasing expansion of this mechanistic mode of inquiry.[457] The guiding question, however, is always how one can bridge archaeological patterns and the putative processes that may have shaped them. Since the quest for such dependencies is essentially the attempt to grasp the working principles of particular causally integrated systems governed by 'primary' and 'secondary laws,' this entire species of research leans heavily towards mechanistic world theories.

4.2.3 *Adaptive interfaces, first-movers, and the environmental question*

The third and final example of persistent mechanistic tropes in Anglophone Palaeolithic research takes up the general character of the wider lithic discourse centred on hominin-environment interactions. There is no doubt that the 'environmental question' – i.e., whether and, if so, to what effect human

[454] It has to be said, however, that research relying on 'Middle Range Theory' (MRT) is not automatically committed to a 'mechanistic' worldview. What makes a key difference is usually whether MRT is based on clear-cut uniformitarian principles – i.e., laws and other universal causal processes – or whether it is propelled by (statistical) analogies – i.e., ethnographically attested regularities. While the former tends to support 'mechanistic' modes of inquiry, the latter may easily sustain 'formistic' reasoning. The reason is of course that MRT-analogies often identify 'participation in patterns' as a precondition for secure knowledge formation (for the underlying difference between 'uniformitarianism' and 'analogical reasoning,' see Cameron 1993). In general, MRT has thus the capacity to unify the 'analytic' approaches to the past.

[455] 'Formation theory' is defined here in rather broad terms, as a collection of various approaches that address *site* and *assemblage formation processes*. My definition follows Lucas' (2012: 74) use of the term.

[456] As Bleed (2001: 109) correctly notes, the concept of the 'reduction sequence,' in contrast to the French *chaîne opératoire*, has been developed in close interaction with 'formation theory.' One may in fact argue that the reconstruction of reduction sequences often amounts to applying formation theory (cf. Dibble et al. 2006; Egeland 2008; Braun et al. 2008b). Richter (2018: 47) is therefore right in saying that the term reduction sequence most of the time simply accounts for a 'transformational analysis' of stony raw materials in order to understand the involved *site formation processes* (SFP) [in the sense of *Transformationsanalyse* (see e.g., Uthmeier 2004)]. Depending on the research interests of individual scholars and their scientific background, differential emphasis is thereby placed on the elucidation of 'n-transformations' and 'c-transformations' (*sensu* Schiffer 1976).

[457] As Van Reybrouck (2012: 321-323, Figure 22) has shown, the Anglophone use of primatology-derived information to render the Palaeolithic past intelligible has engendered a constant move back-and-forth between *similarity-based holistic projection* and *causality-based attribute transfer*. In essence, these two alternate strategies of bringing primatological information to bear on the interpretation of the past help further solidifying the thesis that Anglophone *Human Origins* research, maximally broadly and inclusively defined, is characterised by the general discursive tension between 'formistic' and 'mechanistic' tendencies. What Van Reybrouck terms 'similarity-based holistic projection' may well reflect the type of correlative-associative thinking promoted by 'formism,' while 'causality-based attribute transfer' sounds suspiciously 'mechanistic' insofar as it insinuates domain-independent causalities governing organismic behaviour in general.

evolution is propelled by eco-climatic forces – continues to galvanise both individual scholarship and collective research programmes (e.g., Clark 1984; Potts 1996b, 2013; Petraglia and Korisettar 1998; Van Andel and Davies 2003; Shea 2003; O'Connell 2006; Petraglia 2006; Stringer 2006; Marean 2007; Petraglia and Allchin 2007; Jones 2007, 2010; Barker et al. 2007; Petraglia et al. 2007, 2009a, 2009b, 2012; Riel-Salvatore et al. 2008; Wragg Sykes 2009; Boivin 2010; Potts and Sloan 2010; Petraglia and Rose 2010; Riel-Salvatore 2010; Lycett and Norton 2010; Pettitt and White 2012; Barker 2013, 2017; Foley et al. 2013; Dennell 2013; Kuhn 2014 [1995]: 166; Johnson 2014; Petraglia and Boivin 2014; Popescu 2015; Davies et al. 2015; Roberts et al. 2015; Groucutt et al. 2015; Barker and Farr 2016; Clark and Baron 2017; Boivin et al. 2017; Roberts 2017; Robinson and Sellet 2018);[458] the study of lithic technology is also increasingly seen as branch of 'behavioural-strategic' research (Kuhn 1993: 25-27; Shea 2013a: 13f., 2015),[459] in which environmental constraints are a prominent target of investigation and often play key roles in explanatory endeavours. Generally speaking, this pivotal status of the environment in Anglophone lithic research is hardly surprising from a Pepperian point of view. As leading experts of the 'strategic' or 'ecological' approach would readily admit (e.g., Torrence 1983, 1989a; Bamforth 1988; Nelson 1991; Kuhn 1995; Henry 1995; McCall 2007, 2015; Surovell 2009; Shea 2011b; Carr and Bradburry 2011; Bettinger et al. 2015), their central objective is to elucidate *systems of behaviour*, rather than simply describing and explaining distinct assemblages or artefact occurrences (cf. e.g., Isaac 1980, 1981; Butzer 1986; Blumenshine et al. 2012). In mechanistic terms, these 'systems' must be recognised as operating in a specific 'environment,' providing some of the relevant external *stimuli* to which hominins, just like any other organism, must respond (cf. Pepper 1942: 226f., 228). Since mechanism predicates the 'specifity of response,' both the 'structure' and the 'configuration' of past behavioural expressions must somehow be linked to the environmental conditions in which they occur. Usually, this requires the introduction of a general *mechanism* connecting environment and behaviour and rendering the observed patterns of behaviour *consequential*, that is, they are shown to be unsurprising. In this way, systems of behaviour can come into view as causally integrated wholes. They encapsulate a 'behavioural machinery' with a specific 'field of locations' and distinct regulatory 'principles' and 'laws.'[460] This basic research configuration clearly resonates with Torrence's (1989b: vii) directive "to look at the general causes lying behind the variability in stone tool form and production," and reproduces the ordered quadruple *composition-environment-structure-mechanism* which Bunge (2013: 590) has identified as the conceptual bedrock of mechanistic world-making. Shea (2013a), in a similar vein, characterises the resulting rationale of 'behavioural-strategic' inquiry in the following manner:

> "[Behavioral-strategic] approaches place more emphasis on reconstructing particular aspects of prehistoric behavior and less on formal taxonomic divisions among lithic assemblages. […] These studies focus on technological variation among cores, flakes, and retouched tools, related to "strategic" variation in raw material economy, mobility patterns, artifact designs, and tool curation. Most practitioners of technological organization approaches are less concerned with evaluation the relative significance of different behavioral factors, such as residential versus logistical mobility, and their correlated technological strategies in the formation of particular archaeological assemblages." (*ibid.*: 13f.)

[458] A number of influential idea and theories revolve almost exclusively around the environmental theme: Potts' *environmental variability hypothesis* (1996a, 1996b, 1998, 2007, 2012a, 2012b, 2013), according to which human evolutionary history parallels the earth's environmental history (cf. Behrensmeyer et al. 1992; Potts and Sloan 2010); Finlayson's *water optimisation hypothesis* (2013, 2014) and his *glacial refugia hypothesis* (2004, 2008, 2009; cf. Finlayson et al. 2000, 2012; Finlayson and Carrión 2007); Mellars' *'Garden of Eden' hypothesis* (2002, 2006, 2009); Marean's *'Aquatic Paradise' hypothesis* (2007, 2010, 2011); and Ambrose's *volcanic bottleneck hypothesis* (1998, 2003; cf. Hoffecker 2009; Jones 2012).

[459] Shea (2015) has recently noted that the 'strategic' approach to hominin behaviour owes a great debt to the provocative connection between John Tooby, anthropologist and co-founder of the "hard" *Evolutionary Psychology* programme (cf. Cosmides and Tooby 1987, 2009), and Irven DeVore, student of famed primatologist Sherwood Washburn and co-editor of the seminal *Man the Hunter* volume (Lee and DeVore 1968). He re-casts their joint paper *The reconstruction of hominid behavioral evolution through strategic modelling* (Tooby and DeVore 1987) as a founding document of the strategic approach. An important aspect of this approach, then, is that it crosscuts the human-animal boundary or any other species-level differences for that matter – it is "substrate-neutral." Although Shea's argument concerning the specifics of intellectual inheritance will surely be contested by others, it assures us of the general epistemological affinity between socioecological reasoning, *Evolutionary Psychology*, and strategic research endeavours in Palaeolithic archaeology. Interestingly, Lee and DeVore's 1987 paper in fact addresses an until this day largely unresolved issue, namely the conceptual and methodological integration of *Behavioural Ecology* and *Evolutionary Psychology* (see Shea 2011c for a number of archaeological problems related to this issue). The strategic approach, in other words, holds his share in the scientific effort to render the study of behaviour a unified and universal enterprise. The call for a general theory of behaviour (O'Connell 1995) is a distant call of the same 'foundationalist' ambition (cf. Van Reybrouck 2012: 227).

[460] Cf. Chapter 2: esp. **Box 7**.

Isaac's (1978, 1980, 1981, 1989) landscape-ecological reconfiguration of Lower Palaeolithic archaeology in Africa – epitomised by his memorable desideratum of 'casting the net wide' (cf. Sept and Pilbeam 2012) – may count as an early attempt to adopt a 'behavioural-strategic' research perspective. His 'palaeogeographic' approach (cf. Behrensmeyer 2012) shifted the attention away from well-stratified, high-quality sites to the organisation of hominin activity on a landscape scale.[461] The perhaps central departure from conventional approaches to the lithic record concerned this notion of the *site* itself (cf. esp. Dunnell 1992).[462] Isaac emphasised the enormous informational value of doing 'off-site archaeology' or even 'non-site archaeology' (cf. Foley 1981; Ebert 1992) and of systematically surveying and mapping mini- and nano-sites, low-density scatters, and other artefactual occurrences indicating hominin activities 'between the main artefact patches' (Isaac and Harris 1980; cf. Isaac et al. 1981). The whole point of this new research strategy was to conceive of lithic technology as an active participant in geographically-framed systems of artefact production, transport, utilisation, and eventual discard (cf. e.g., Blumenshine and Masao 1991; Blumenshine et al. 2003, 2008, 2009, 2012; Plummer 2004; Braun 2006, 2013; Braun et al. 2008a, 2009):[463]

> "The landscape paleoanthropological approach was adopted to broaden the site-scale focus of Leakey's excavations to the whole lateral extent of Oldowan-aged deposits, including those with less conspicuous or no apparent archaeological occurrences (Isaac et al., 1981). Similar approaches described collectively as landscape archaeology (e.g., Wandsnider, 1992) include "off-site archaeology" (Foley, 1981), "non-site archaeology" (Thomas, 1975), "siteless survey" (Dunnell and Dancey, 1983), "scatters-between-the-patches" (Isaac and Harris, 1978), and "distributional archaeology" (Ebert, 1992). None of these approaches assume that high-density artifact occurrences, such as many of those excavated previously at Olduvai, are representative of hominin activities involving material discard. Rather, individual artifact/bone occurrences in the landscape array are material traces of different phases of a subsistence continuum (cf. Binford,1982), which had been demonstrated for Olduvai's Oldowan to include the acquisition, processing, transport, and use of stone and carcass resources (Stiles et al., 1974; Bunn, 1981; Schick, 1987; Toth, 1987)." (Blumenshine et al. 2012: 248)

Isaac (1986: esp. Fig. 15.6; **Fig. 22**) explicitly contends that one has to abandon the notion of lithic items or toolkits as 'fixed' or 'static' entities and instead regard them as ""fallout" of more complex systems of artefact extraction and management." Geographic space, in other words, is viewed as a medium in which a network of activities with more or less delineated artefact patches becomes apparent. This conception not only takes up the productive tension between 'static' and 'dynamic' (see previous section), but also considers the question of where a site begins and where it ends as meaningless; the distinction between 'sites' and 'empty space' between them becomes practically arbitrary. Hominin behaviour is regarded to act as an 'irrigating' force that potentially covers up the entire landscape and produces a "veil of stones" of varying density and composition (*idem*).[464] The recognition that, realistically, this 'stone curtain' must be conceptualised as a *continuous* entity is extremely crucial. Isaac's model of hominin land-use pictures geographic patterns in the lithic data as the result of an 'integrated spatiotemporal system of behaviour' in which any residual discreteness is resolved. The system itself,

---

[461] For an early example of this lasting re-orientation of Palaeolithic research in Africa, see Harris and Isaac (1976).
[462] In prototypical mechanistic fashion, Dunnell (1992) problematises the 'reality' or 'relevance' of a *site* as a unit of observation and analysis. He (*ibid*.: 21f.) argues that the concept is defective and hampers the recognition and appropriate interpretation of the continuous distribution of artefacts on the scale of a landscape and underestimates the contemporaneity of much of the observable patterns (cf. Dunnell and Dancy 1983). Instead of a site-centred approach to the past, Dunnell (1992: 33-36) proposes a 'siteless' approach in which individual artefacts constitute the smallest units of observation. As we will see below, this represents a classic 'mechanistic' position.
[463] This distinct approach to landscape-scale hominin behaviour is consistent with what Rossignol (1992: 4f.) has outlined as the *landscape approach* contrasting with interpretive landscape archaeology in the wake of Tilley, Hodder, Bender, Thomas, and Roberts: "[w]e define *landscape approach* as the archaeological investigation of past land use by means of a landscape perspective, combined with the conscious incorporation of regional geomorphology, actualistic studies (taphonomy, formation processes, ethnoarchaeology), and marked by ongoing reevaluation and innovation of concepts, methods, and theory. This landscape approach not only provides a common theater for a variety of archaeologists to interact, but, more importantly, it provides a directed, but flexible, orientation for theory building. In other words, our landscape approach addresses regional-level problems in archaeology by capitalizing on the interaction among regional-level geological, ecological, and actualistic studies. This framework takes inspiration from Butzer's contextual approach (Butzer 1982; see also Hassan 1979) and Foley's regional taphonomic and off-site approach (Foley 1981a, b). Our landscape approach differs substantially from landscape archaeology. Because of their explicitly historical emphasis, method and interpretation of landscape archaeologists do not incorporate ecological and geological system variables. Both British and American practitioners of landscape archaeology assert an historical and (Hodderian) contextual focus for the discipline (Roberts 1987; Deetz 1990; Crumley and Marquardt 1990)." (original emphasis)
[464] Note that this realisation prompted a number of important methodological changes in how one would "sample" a palaeoanthropological landscape by systematic and semi-random test-trenches on a lager geographic scale (cf. Blumenshine et al. 2012: 248).

therefore, ultimately comes into view as a unified field structure. Hominin behavioural systems thus become intelligible as 'fields of locations,' as differentially configured activity fields with continuous breakpoints. The various 'locations' are connected by hominin movement, and the transport and discard of lithic items – sometimes in a randomised fashion, sometimes planned (cf. **Fig. 22**). In an important sense, sites and other pseudo-discrete aggregates of lithic artefacts therefore describe *metastable states* – locally materialised potentiality of the integrated system.[465]

The 'fallout metaphor,' employed by Isaac (1986) himself, provides indirect support of this interpretation. A 'fallout,' generally speaking, is the product of radioactive decay or the entropy of a system and always affects a larger geographic area; it typically becomes manifest as a constant rain of atomised matter. The point is that in the case of hominin behaviour, the fallout metaphor suggests that varying configurations of artefacts are *realisations of field properties*, i.e., a consequence of the basic 'geometry' of the underlying causally-integrated field (*sensu* Pepper 1942: 215).[466] Alternatively, we may understand the use of the fallout metaphor as a convenient means to indicate that lithics represent 'derived' categories of reality whose 'primary structure' is laid out by the respective behavioural system and its regulatory mechanisms. The 'veil of stones' conveys the particular 'appearances' that are correlated with this 'primary structure.' In mechanism, the concept of 'emergence' is usually mustered to describe this specific relationship between the 'primary' and 'secondary' categories of existence (cf. *ibid*.: 217).[467] In any case, this conceptual exposition makes clear that Isaac's landscape-ecological approach tackles hominin behaviour as an expression of a broader spatiotemporal machinery whose 'composition,' 'environment,' 'structure,' and 'mechanism' need to be disclosed (*sensu* Bunge 2013). The explanation of lithic reality is therefore *subsumptive* (*ibid*.: 591) – individual artefact occurrences and characteristics are explained by organisation and functionality of the behavioural system in question. The approach thus clearly carries the sparks of a 'consolidated' mechanism (cf. Pepper 1942: 212-221).

As Blumenshine et al. (2012: 248) have remarked, one of the main challenges of the landscape-ecological approach is to actually advance from the landscape evidence to critical aspects of 'hominin ecology'. The problem is that the evidence for hominin behaviour on a geographic scale – in part also because of the immense methodological and practical issues that such an approach has to overcome – is typically "too fragmentary and incomplete" to serve as the sole baseline for reconstructing hominin ecology (*idem*). Symptomatically, Blumenshine et al. (*idem*) therefore suggest to rather view the landscape-ecological approach as an instrument to test and refine *substantial theoretical models* of hominin ecology; this explicitly model-based procedure, in their view, would pave the way toward a more fruitful engagement with past behaviour and ecology. Based on earlier work on interface between landscape ecostructure of the Olduvai basin, including the distribution of key resources, and hominin site composition and distribution therein (cf. Peters and Blumenshine 1995, 1996), Blumenshine and Peters (1998) offer a predictive model of Lower Palaeolithic hominin ecology in the area to accommodate this demand. This model is intended to derive testable predictions about the interlinkages between "particular landscapes, particular hominids, and their associated technologies in a particular time and space" (*ibid*.: 568). Blumenshine and Peters (1998) explicitly note:

> "In order to use the archaeological record to test hominid land use models, hominid behaviors must be linked predictively to their material traces by causal ecological mechanisms related to the ecostructure of specified landscape facets [...]." (*ibid*.: 571)

In a first step, Blumenshine and Peters (1998: 569, 571) reconstruct the abundance and variety of 'affordances' (*sensu* Gibson 1977) tied to varying 'landscape facets.' This landscape facet represents a relatively homogeneous local landscape-segment which broadly corresponds to a general habitat type

---

[465] See the previous section for an explanation of the concept of 'metastability' and its relevance for 'mechanism' in conceptualising lithic reduction processes.

[466] Cf. "It is even possible to conceive of atoms popping in and out of existence all over the field, so long as their popping should conform to the structure of the field. That would, after all, be the fully discrete treatment of atoms in the field. The fact that we instinctively reject the idea indicates that a fully discrete mechanism has never been seriously contemplated." (Pepper 1942: 203)

[467] 'Emergence' is therefore typically defined as 'weak' insofar as an intimate connection to the respective 'primary structure' of reality is maintained (see e.g. Greve and Schnabel 2011 for a discussion of 'weak' versus 'strong' emergence). This not only ensures that 'mechanism' can sustain its 'bottom-up' research agenda, but also shows that the role of the concept is to explain the directed transition between 'reality' and 'appearance,' rather than to theorise the reality of system-level properties that are more than the sum of their parts. In mechanism, 'weak' emergence simply signals the correlatedness and structural quasi-identity" of the 'primary' and 'secondary' categories of reality.

(*ibid*.: 569). The 'affordances' of this landscape facet are defined as the sum of the possibilities for interaction that result from the combination of its properties, substances, and surfaces (*idem*); the associated potential for 'hazards,' i.e., the structure of risk tied to certain interactions, is also included. Blumenshine and Peters (*ibid*.: 571) argue that the character of these facet 'affordances' ultimately *determine* the nature of the encountered artefactual traces. In a second step, different landscape facets and their material lithic and non-lithic correlates are compared in order to isolate inter-landform differences in hominin-affordance interactions (*idem*). In a third and final step, then, these patterns of eco-behavioural co-variation are shown to be the inevitable consequence of particular *ultimate* and *proximate* mechanisms (*ibid*.: 571f.).[468] As proximate mechanisms, the authors discuss several breakage patterns of bone and stone linked to particular extraction and knapping behaviours (idem), whereas ultimate causes are identified as various "ecological mechanisms" (*ibid*.: 572-580, Figure 1). These mechanisms define a *causally and functionally integrated system of hominin-landscape interaction* with distinct and largely unambiguous empirical correlates. Blumenshine and Peters (*ibid*.: 572-578) for example list varying scavenging opportunities ('scavenging affordances') and changing levels of inter-carnivore competition for carcass-access as primary ecological mechanisms. They further maintain that the function and transport-patterns of lithic artefacts reflect the technological organisation of hominin activities and that the two can directly be linked to the ecological mechanisms in terms of the density and composition of archaeological occurrences – distance to the nearest raw material sources ('flow model') and activity-relative safety play key roles here (*ibid*.: 578). We do not need to go into the details of their certainly impressive account in order to recognise that their reasoning is thoroughly mechanistic. The behavioural system[469] they wish to reconstruct is re-cast as a *causally determined structure* in which the relevant constitutive relationships are singled-out, described, and linked to each another;[470] truth is secured and knowledge corroborated by means of *causally adjusting* the specified factors of reality. Prediction amounts to a key operation (cf. *ibid*.: 595-599) and, insofar as the predictions can be successfully tested, is *co-extensive* with explanation.[471] Again, lithic technology comes primarily into view as a 'derived' phenomenon – as a 'problem-solving' device that responds to the more basic stimuli of its operating environment (*sensu* Pepper 1942: 226-228).

Braun et al.'s paper *Landscape-scale variation in hominin tool use: evidence from the Developed Oldowan* (2008a) subscribes to a similar approach.[472] The authors use techniques of digital-image analysis to accurately measure lithic core reduction intensities, which they proxy by the ratio between single platform core mass and the relative platform area of the core. They then map the aggregated values of calculated 'reduction intensity' onto the palaeogeographic setting in which the respective cores have been discarded (*ibid*.: Fig. 5; **Fig. 23**). Although the pattern does not conform to the 'flow model' or 'distance-decay' scenario of raw material use,[473] which would predict an intensifica-

[468] The distinction between 'ultimate' and 'proximate' mechanisms in evolution has been popularised by Tinbergen (1963, 1965). Tinbergen proposed to place the study of behaviour on his famous *Four Whys*: (i) causation, (ii) adaptation, (iii) phylogeny, and (iv) ontogeny. While Tinbergen's ethology was essentially conceived as a 'mechanistic' science, he maintained that multi-causal explanation is often superior to mono-causal accounts. He stressed, however, this condition requires the analyst to neatly discriminate between different kinds of causes. The distinction between 'ultimate' and 'proximate' causation also served this larger purpose. 'Ultimate' mechanism are the 'first causes' and most elementary explanations for a given phenomenon. An ultimate explanation for a phenotype would be its genotype or its shape-giving selective pressures. 'Proximate' mechanisms, by contrast, are 'secondary causes' [*Wirkursachen*], that is, the more immediate reasons that lead to certain behaviours. Such reasons are often directly tied to the physiology or ecology of the organism in question.

[469] For an explicit usage of the term 'behavioural system,' see e.g. Tyron and Potts (2011: 376, 383).

[470] Cf. "The direct and indirect causal pathways involved in deducing archaeological patterning from the ecostructure of landscapes are complex (Figure 1). Nonetheless, our predictions about trace fossils of hominid landscape interactions rest upon two simple principles." (Blumenshine and Peters 1998: 600)

[471] Cf. "Our ability to identify the source(s) of potential flaws in the models, and therefore to revise them in ways that reflect this improved understanding of prehistoric hominid ecology, is enhanced by the systematic and explicit manner in which the predictions are generated. Even if the precise source of the flaws eludes us, the structure of the land use model (Figure 1 and Tables 1 through 3) serves the valuable function of systematically organizing thought on a subject matter that traditionally has been treated inductively with respect to the archaeological record, and that has generated no independent and incisive test implications." (Blumenshine and Peters 1998: 600)

[472] Cf. "[…] Variability also appears as a major feature of the Oldowan archaeological record. This may be the result of the numerous hominin species that existed throughout the Oldowan period (Delagnes and Roche 2005). Yet a more testable explanation is that Oldowan behavior is very sensitive to its ecological context (Plummer 2004). If this is the case, paleoecological analyses conducted in concert with Oldowan archaeological projects is crucial. If Oldowan archaeologists can understand behavioral patterns relative to varied environmental contexts, it may be possible to really understand the ecology of early Pleistocene hominins." (Braun 2013: 342)

[473] For discussions and applications of the 'distance-decay model' (Renfrew 1969; Clark 1979), see e.g. Dibble (1995c), Roth and Dibble (1998), Brantingham (2003), and Blumenschine et al. (2008: 78).

tion of lithic reduction as the distance to the nearest raw material source increases, the authors are able to show that palaeogeographic discard patterns exist and that there is a trend towards increasing reduction intensity as one moves away from water bodies. Braun et al. (2008a: 1061) add that the respective transport decisions also show that the assessment of the potential use-life of the objects probably played a significant role. They (*idem*) conclude that this behaviour reflects a strategy of 'mitigating the risks associated with a subsistence pattern that requires sharp-edged tools.' This study not only showcases 'causal-adjustment reasoning' and the use of standard-predictions (*ibid.*: Fig. 6) to facilitate interpretation, it is also decisively 'integrative.' The distribution of lithic assemblages in the wider landscape is effectively explained by a *single measure* – a measure that is argued to causally bridge hominin activity and ecology.

Jochims' (1991, 1998) model of the relationship between hominin settlement pattern and environmental structure provides another illustration of the mechanistic reconstruction of causally-integrated behavioural systems. The author (1991: Figure 1) theorises the basic causal-determinative linkages that define the temporal and spatial axes of such an integrated system (**Fig. 24**). The model entails specific predictions designed to guide the examination of particular empirical cases. It pays particular attention to the relative strength of particular linkages and their relative symmetry under different conditions. The main regulating factor in the model is the nature of *environmental variability*. Jochim (*ibid.*: 311) simply recognises that some nomadic groups face temporally variable but spatially relatively stable environments, or the other way around. Alternatively, the hosting environments may be coevally variable or stable on both temporal and spatial coordinates. In general, he asserts that the temporal and spatial structure of the environment affects the abundance and distribution and thus the locational and temporal predictability of key resources (*ibid.*: 311-313). This, in turn, will shape the patterned association between the location of campsites, seasonality, and the activities carried out there. The result is the identification of five ideal-typical archaeological "signatures" (*ibid.*: 313, Figure 1: A-E; cf. **Fig. 24**). It is easy to see that this systemic articulation of environmental structure, resource availability and predictability, and human settlement pattern describes the mechanistic quadruple *composition-environment-structure-mechanism* (*sensu* Bunge 2013).[474] It is also clear that the various domains of reality are connected by directed 'causal chains' and that there is a simple 'hierarchy' among these chains: the environment constraints the resource potential, and the resource potential constraints human settlement:

> "If the various typologies of hunter-gatherers are taken as a guide, [...] [behavioral] variability is not necessarily characteristic of all groups, nor is it randomly distributed among them. Rather, it is directly related to characteristics of their natural environments: variability of behavior is directly related to variability in the environment. An examination of different sorts of environmental variability leads to some conclusions about the structure of behavioral variation." (Jochim 1991: 311)

Thus, the further up this chain a phenomenon is situated, the more 'derived' it appears. It must consequently be explained in terms of the qualities of the next lower stage of the chain. These seemingly derived qualities, then, are interpreted as 'secondary qualities,' while the *causing* qualities are identified as the 'primary qualities.'[475] The designation of 'primary' and 'secondary qualities' may of course change as one moves up and down the ladder. Yet, the important point is that conceptions like this rely on the 'hierarchy of response model' of ecological functioning (*sensu* Miracle 1995: 3; cf. Nelson 1991: Figure 2.1; Hoffecker 2002: Fig. 1.6; Steenhuyse 2007: 11-24; McCall 2015: Figure 2.4; **Fig. 25**). This notion is not only the hallmark of 'hard ecology' approaches, but reflects the mechanistic perception of the world as a 'layered cake' [*Schichttortenmodell*] (cf. Hahn 2013: 34; **Appendix II.3: Fig. II.1**),

---

[474] Cf. "By recognizing and concentrating on the *variability* in settlement pattern and structural data, both within and among hunter-gatherer systems, it becomes possible to propose that patterns of organization relate to conditions external to the examined systems and to begin to do pattern recognition studies in these domains. [Julian] Steward, of course, was a pioneer in the investigation of the ecological relationships that hunter-gatherers maintained with their environment, and it may be that all of his work, his research in this domain constitutes our most important inheritance." (Binford 2001: 30; original italics)

[475] Talking about 'mediating' or 'intermediate' layers of reality – for example mobility – regulating environmental adaptation does not change this situation. These constructions simply spell out what it means to invoke a causal chain. In the case of mobility for example, lithic technology is typically construed as an adaptation to mobility requirements, that is, to the specific mobility system in place, but the mobility system is itself regarded to be an adaptation, namely to particular eco-environmental conditions (cf. Straus 1996: 95-96; Thacker 1996: 120-121; Bettinger 1998: vi; Riel-Salvatore and Barton 2004; Hopkinson 2004; Ambrose 2008). These constructions effectively increase the *focus* and *precision* to the analysis – two highly valued virtues in any 'integrative-mechanistic' framework of inquiry.

emphasising the 'bottom up' assembly of distinct compartments of reality.[476] Depending on the strength of the respective ontological claims, such approaches tend to adopt a more or less 'discrete' version of mechanism (cf. Pepper 1942: 195-212). This mechanism allows for residual 'discreteness' among its elements – in fact, discreteness turns out to be a crucial precondition of *externally relating* these elements.[477] The prototypical case of 'causal adjustment' – and thus of demonstrating 'cause-and-effect' relationships – consequently tends to support 'discrete' interpretations of mechanism,[478] rather than its 'consolidated' variant; in 'discrete' incarnations of mechanism, *heteronomic strategies* of explanation can more easily be maintained. The fact that Jochim (1991) frames his general model and its application to the South German record of the Magdalenian-Holocene transition as "long-term ethnography" finally illustrates that Pepper's world theories crosscut conventional academic divisions and that mechanistic reasoning is not just a matter of 'behavioural-strategic' or strictly 'ecological' approaches.

Mellars' (2001, 2006: x-xi, 2009) reconstruction of the dramatic demographic and social changes during Oxygen Isotope Stage 3 (ca. 50-30 kya), for instance, amply illustrates the kind of causal-inferential chain which is typically summoned by mechanists:

> "To cut a long story short, I argued that the rapid climatic and ecological changes of OIS 3 would inevitably have promoted major shifts in both the distribution and overall densities of human populations in different areas of Europe, which in turn would have led to a sharp increase in the frequency of population interaction, and direct competition, between the adjacent groups for both space and resources. All of these competitive social pressures, combined with the scale of the environmental changes themselves, would have had equally inevitable impacts on the subsistence activities and associated technologies of the human groups, leading to inevitable, if not entirely predictable, patterns of technological change. A number of social adaptations (such as the formation of larger residential units, or perhaps increased separation of individual economic and social roles within the individual groups) could be seen as equally plausible adaptations to the combined environmental and demographic pressures." (Mellars 2006: x-xi)

The highly influential 'Cambridge school' of *palaeoeconomics* established by Eric Higgs and his followers (cf. Coles and Higgs 1969; Vita-Finzi and Higgs 1970; Higgs 1972, 1975; Dennell 1983; Bailey and Parkington 1988) similarly stresses the derived nature of lithic technology and considered patterns of technological organisation as a specific response to the needs and characteristics of its correlated 'subsistence economy.' Higgs himself (1972, 1975) at times even came close to regarding lithic technology as a mere *epiphenomenon*. In the introduction to *Palaeoeconomy*, Higgs and Jarman (1975: 3f.) explicitly note that

> "[...] the primary human adaptation to the environment is the economy [...]"

and

> "[p]alaeoeconomic studies lay their main stress on a basic aspect of human behaviour which can be shown to conform to predictable laws over long time periods."

The core business of the 'palaeoeconomic approach,' namely to reconstruct subsistence economies, was, in other words, thought to be in principle independent of what was regarded to constitute 'cultural data,' including stone tools (cf. Barker and Dennell 1976; Bailey 1999: 552-557). Although this view certainly represents an extreme voice in the wider Anglophone scene, it spotlights the potential ramifications of an extreme version of mechanism in lithic studies. By embracing a radical conception of a layered reality-assembly, Higgs was obliged to also adopt a radically 'integrative' stance. According to this position, only the economic conditions can count as 'real' since only they serve the immediate purpose of survival and livelihood. All other phenomena must consequently be thrown into the 'unreal.' Being 'unreal' in this sense does not necessarily imply that the phenomena in question do not exist, it simply points to the fact that they cannot claim to possess 'independent existence.' They can thus

[476] Within 'consolidated mechanisms,' the 'hierarchy of response model' is interpreted to suggest that there must be a 'first mover' – a *causal singularity*. This singularity ultimately confirms that only a single particular 'truly exists' (cf. Pepper 1942: 214). This single particular, in a perfect mechanistic world, is of course the fully integrated field structure itself.

[477] This is precisely the point where 'mechanism' is threatened to collapse into a refined version of 'formism' emphasising discreteness and similarity (see **Appendix II.2** for a detailed discussion).

[478] See for example Basell (2008) who employs an explicit 'push and pull' logic to explain the distribution of archaeological sites during the East African Middle Stone Age (MSA).

fully be reduced to their constitutive factors. In the conceptual language of mechanism, the respective phenomena amount to the 'ineffective' categories of reality; they describe merely the 'secondary qualities' of the more basic and hence 'effective' categories of reality. This epiphenomenalisation of lithic technology is just another symptom of the mechanistic exigency of negotiating the *Appearance and Reality* gap (see the previous section and *supra*).

What seems to guide most of these approaches, independently of their specific intellectual background, is the notion of a *functional-systemic equilibrium*. The objective of Anglophone mechanistic lithic research is often to find the precise conditions under which the functionally related components of a behavioural system – e.g., lithic technology, mobility, and the natural environment – can be said to be 'in balance.' The total system effectively inaugurates a principle of 'checks and balances' from which no component has reason to break out. The *equilibrium* describes a state in which the components are causally-related in such a way that changing one component would most likely change the whole system. Pepper's (1942: 227-230) principle of 'causal adjustment' is simply the specification of an *equilibrium* state in which the components causally enforce each other – 'causal adjustment' consist in the *causal coordination* of the 'effective' parts of reality. We can speak of *equilibrium* because the mechanistic logic implies a *symmetry* between 'push' and 'pull' or 'cause' and 'effect' (cf. Pepper 1942: 190). Within the framework of the 'behavioural-strategic' paradigm, equilibrium conditions are typically modelled as 'best' responses. In the extreme, the match or mismatch between *strategic equilibria* and actually realised responses may be taken as a measure for 'adaptive performance' (cf. Krebs and Davis 1978; Winterhalder 1981, 2001; Winterhalder and Smith 2000; Bird and O'Connell 2006).[479] Implicitly or explicitly, equilibrium reasoning is inspired by economic 'game theory' (e.g., von Neumann and Morgenstern 1944; Nash 1950), especially its evolutionary branch (e.g., Taylor and Jonker 1978; Maynard Smith 1982; Skyrms 2001, 2004), and typically feeds into 'Deductive Equilibrium Methodologies' that provide the cognitive resources to detect and analyse 'rational expectations' and phenomena such as 'Bayesian Nash Equilibria' (cf. Van Huyck et al. 1990).

Some of these economic ramifications of mechanistic thought will be taken up in the following sub-sections. I will first address the underpinnings of *Human Behavioural Ecology* (HBE) and of what is known as *Technological Organization* (TO) before discussing two specific economic approaches to reconstruct the "coming together" of stone tool technology and hominin behaviour.[480] These examples will help to further lay bare the epistemological stakes of mechanistic reasoning in Anglophone lithic studies.

'Human Behavioural Ecology,' 'Technological Organisation,' and the currency of causally-integrated systems of behaviour

The 'behavioural-strategic' (e.g., Hoffecker 2001, 2002; Odell 2001; Adler 2002; Elston and Brantingham 2002; Wallace and Shea 2006; Adler and Tushabramishvili 2004; Surovell 2009; Shea 2011b, 2013a: 13f., 2017a; Kelly 2013: Chapter 5, 2014; Churchill 2014) and the 'organisational approach' (e.g., Binford 1973, 1979; Torrence 1983, 1989c; Bleed 1986; Kelly 1988; Bamforth 1991; Nelson 1991; Bousman 1993; Kuhn 1995; Bamforth and Bleed 1997; Carr and Bradburry 2001, 2011; McCall 2007, 2015: 61f., 79-90), while representing the two main mechanistic lithic research frameworks, are built on broadly similar methodological and epistemological maxims and often overlap in practice. This is not to say that there are no important divergences and conceptual tensions between the two, but these are relatively minor and can be neglected for the present purpose. We have already seen that both approaches make productive use of the assumption that lithic technology is one of many factors contributing to an integrated spatiotemporal system of behaviour (cf. Tyron and Potts 2011).[481] Yet, technology is not just any factor; it represents the primary means with which hominins access their social and

[479] The study of 'maladaptation' is logically implied here. 'Non-adaptive' behaviour can then be defined as behaviour that deviates from the derived optimality expectations (cf. Jochim 1983).

[480] The latter two examples have been sampled from the recent volume *Lithic Materials and Paleolithic Societies* edited by Adams and Brooks (2009).

[481] For a specific emphasis on the aspiration of processual archaeologies to scientifically reconstruct 'behavioural and formational systems underlying the organisation of the archaeological record' (Rossignol 1992: 5), see also Willey and Sabloff (1980: 195) and Dunnell (1986: 38). Even 'adaptation' is understood as a systemic variable – as the 'congruence' or external relatedness of systemic components (i.e., cultural organisms and their environment) (Binford 1978: 3; cf. Rossignol 1992: 5, footnote 1).

natural environments, extract energy, and potentially change these environments. Technology, therefore, occupies a key position at the interface of compartments and domains of reality (e.g., Isaac 1977a, 1977b; Butzer 1977; Jochim 1981; Kuhn 2011; Kelly 2016: Chapter 3, esp. 28, 32).[482] It is this interfacing status that renders lithic technology fundamentally 'mouldable.' While the 'discrete' mechanist would argue that this technological 'plasticity' is a necessary result of the 'causal adjustment' of the different parts of reality and the tendency of wholes to find seek out *stable equilibria*, 'consolidated' mechanists would simply maintain that since there is no place for discreteness in reality, technology automatically merges with its underlying field-structure, leaving almost no inherent 'sturdiness' behind.[483] Shott et al. (2011) give a voice to this 'received view' of *technological customisability* when they note:

> "[...] The systematic production of usable flakes is often presented by lithic technologists as a rigid set of strategies or procedures to be followed in a step-by-step fashion. The quintessential example is the *chaîne opératoire*, developed by the French in the 1980s and widely applied today. An alternate view is that lithic reduction is a fluid behavioral set conditioned by an intimate familiarity with techniques and materials and tempered by environmental and situational circumstances." (Shott et al. 2011: 320; original emphasis)

This recognition of lithic technology as a fluid behavioural set tempered and conditioned by environmental and situational factors remains central to both 'behavioural-strategic' and 'organisational' approaches. As Torrence (2001: 73) correctly points out, this conception allows one to engage with the 'Big Picture' of how lithic variability is shaped and structured. To conceive of lithic technology as a 'plastic' entity enables the focused investigation of the relative strength and significance of the various *causal factors* that might have contributed to the formation of particular lithic assemblages and technological signatures. 'Discrete' mechanism would thereby concentrate on individuated causal variables, whereas 'consolidated' mechanism usually focuses on 'constraints' (cf. Goldratt 1996). This talk about 'constraints' signals that technology is analysed in terms of its *relative position* within the integrated behavioural system. A 'constraint' is a factor or element that restricts another entity, that is, it prevents that entity from achieving its potential alternative goals; constraints create bottlenecks and thereby regulate the expression of the constrained phenomena.[484] At least two points are important here. The first is that the character of technological expression depends on its 'location' in the larger machinery of which it is a part (*sensu* Pepper 1942: 191, 197). Each part of the behavioural system, in other words, is constrained by its position in the 'field of locations' and thus by all other 'locations' connected to it. This brings us to the second point, namely that speaking about constraints in this manner means speaking about the *properties of the mechanistic field-structure*. The relevant constraints are only understandable if the entire quadruple *composition-environment-structure-mechanism* is taken into account. 'Constraints,' understood in this way, do not stand for discrete processes anymore but describe *field forces* and *field potentials* that can precisely be quantified.

In Anglophone lithic inquiry, scholars typically convey this research orientation by conjuring the study of technological 'costs and benefits,' and the relative trade-offs between different economic factors and design decisions (cf. Torrence 1989c: 2; Ambrose and Lorenz 1990; Kuhn 1993, 1995; Bousman 1993; Carr and Bradburry 2011: 308, 310; Shea 2011a, 2013a: 39).[485] Researchers have mustered an entire array of potential 'currencies' to measure the strength and significance of the active 'field forces' that give shape to a particular behavioural system. The most popular currencies are 'energy,' 'calories,' 'time,' 'uncertainty,' 'security,' and especially 'risk' (e.g., Torrence 1989c: 3, 2001: 73-78; Blumenshine and Peters 1998; Bright et al. 2002; Ugan et al. 2003; Bettinger et al. 2006). Other more object-centred currencies are for instance the 'portability' and 'curational potential' of lithic artefacts (e.g., Binford 1979; Cole 2009; Kuhn and Miller 2015), but also the design-properties of lithic implements or complex projectile delivery systems, i.e., their 'functional efficiency,' 'versatility,' as well as

[482] Churchill (2014: 53-59), for instance, speaks explicitly about 'lithic technology as an adaptive interface.' This notion, *grosso modo*, of course resonates with Binford's (1962: 218) influential proclamation of "culture as an extra-somatic means of adaptation"

[483] Borgerhoff Mulder (2005), for instance, underscores the 'extreme phenotypical plasticity' which HBE approaches typically predicate.

[484] See Cox and Goldratt (1986) and Goldratt (1990) for a general 'theory of constraints.'

[485] Shea (2011b: 14), for example, argues that the link between lithic patterns and hominin behaviour should be studied in "strategic terms, to seek the cost-benefit structure of the incentives underlying particular behaviors, and to document variation in the contexts in which particular behavioral strategies are deployed (or not)."

their 'reliability' and 'maintainability' (cf. Bleed 1986, 1997; Nelson 1991; Bamforth and Bleed 1997; Hopkinson 2004; McCall 2015: 80). The regulative idea is that some or all of these currencies have to be *optimised*, yet under general conditions of constraint. Bruce Winterhalder (2001: 31-33) has referred to this core feature as the 'assumption of constrained optimisation.' Optimisation is simply described as some kind of 'utility' that is maximised under conditions of scarcity and systemic constraint. The utility function that can be extracted by analysing and comparing the role of some or all of the relevant currencies within the behavioural system helps understanding why lithic technology takes particular forms and what the systemic role of particular lithic 'locations' is. To isolate, theorise, and investigate variable currencies and their role in structuring 'systems' and 'locations' facilitates the recognition of the *causally-integrated whole* that mechanists wish to illuminate. These currencies are nothing else than causal variables that are evaluated in terms of their relevance and explanatory power. The *adjustment* of these currencies in changing temporal and spatial contexts provides lithic experts with the means to come up with hypotheses about the "working" principles of the behavioural machinery seek to decipher:[486]

> "Stone artifacts come to us as static entities, but they are products of dynamic behavioral processes. Linking static lithics to dynamic behavior requires one to correlate patterns in variation in the lithic record to variability in behavioral strategies. Strategies are solutions to a specific set of problems determined by the interaction of costs, benefits, and risks on evolutionary actors (Krebs and Davies 1991, Pianka 1988). Modeling strategic variation involves hypotheses about the changing relationship between cost and benefit overt time. The three most fundamental of these relationships are optimization (maximizing benefits per unit of cost), satisficing (obtaining minimally necessary benefits per unit of cost), and intensification (increasing costs in return for unchanging or declining benefits). [...] The precise currencies of costs and benefits involved in various dimensions of lithic variability and how to measure them are much debated. Time, energy, and risk are obvious variables (Torrence 1989, 2001), as they are for nearly all behavior, but other factors specific to stone tool technology involve utility (potential for continued use), versatility (potential for multiple uses), and portability (costs associated with transporting lithic artifacts)." (Shea 2013a: 39)

Torrence's (2001: 78-80) discussion of the role of the 'severity of risk' and its associated 'failure costs' in explaining general latitudinal differences in the technological make-up of ethnographically documented nomadic groups similarly showcases the determinative role of the respective factors and highlights the 'chain of causality' in which they participate:

> "Failure costs, and therefore the level of risk, increase toward the poles because the availability of food decreases with longer winters and there are fewer alternative resources because species diversity has an inverse relationship with latitude. Latitude is therefore a useful proxy measure for severity of risk with higher latitudes having higher risks. [...] The type of tool used to procure animals also responds to increasing failure costs as monitored by latitude. Near the Equator small mammals are mainly hunted with instruments and weapons, but in the far north untended facilities such as traps are more common (Torrence 1983: Table 3.4). Similarly, tended facilities are used in the hunting of large terrestrial mammals to a greater degree in the riskier northern environments than among low-latitude groups." (*ibid.*: 27)

The necessity of *risk management* provides the general 'mechanism' required to link the 'composition' and 'structure' of technology to a specific 'environment' (cf. Read 2008; Hoffecker and Elias 2003, 2007; Hoffecker 2005). Risk, in other words, emerges as the 'lubricating' stuff that keeps the behavioural machinery running. It is not coincidental here that 'risk' is a somewhat curious entity; it is neither material, nor an abstract idea. Rather, it must be understood as a field property which, although being unobservable, delineates a 'primary' and 'effective' category of reality – it is therefore 'real' insofar as it causally conditions the observable.

Nettle et al.'s (2013) praise of HBE research as the study of human behaviour from an adaptive perspective and in terms of how behaviour varies with ecological context – as providing 'clear predictions' and heightened 'methodological rigor' – arguably resonates with the ambition and self-recognition of 'behavioural-strategic' and 'organisational' approaches to lithic technology in Anglophone Palaeolithic archaeology. Nettle et al. (2013) especially highlight the aspiration of HBE to disentangle *ultimate* and *proximate* mechanisms (*sensu* Tinbergen 1963; Mayr 1988; cf. Krebs and Davies

[486] The guiding metaphor here is a complex clockwork with many adjustable screws. The task of the analyst is to adjust them in such a way that the clockwork 'runs' smoothly. This obviously requires finding the correct or effective mechanical links between the various screws and understanding the general 'working' principle(s) of the clockwork.

1978) – they admit, however, that for practical reasons it is usually more profitable to focus on the *proximate* causes – and to integrate the study of 'behavioural variability' with the study of 'behavioural optimality.' Shea's (2011b: 11, 15) insistence on determining the sources of lithic variability is an echo of the same research mandate. Some would certainly argue that this undertaking requires an integration of ecological and Neo-Darwinian evolutionary theory, including relevant subfields such as evolutionary ecology and evolutionary economics (cf. Kuhn 2004a; Bettinger et al. 2015; Goodale and Andrefsky 2015). In general accordance with Torrence (1989c: 4f.), Kuhn (1993), and many others, Borgerhoff Mulder (2005) also stresses the importance of adopting a 'problem-solving approach' in order to examine 'adaptive strategies' and 'how humans have been selected to respond flexibly to environmental conditions in ways that enhance their fitness.' The evocation of classic Darwinian mechanisms such as 'adaptation,' 'selection,' and 'inheritance with modification' in the study of hominin behavioural variability[487] thereby unequivocally earmarks these approaches as mechanistic.[488]

Cole's examination of economic efficiency at the Middle-to-Upper Palaeolithic transition

In *Technological Efficiency as an Adaptive Behavior Among Paleolithic Hunter-Gatherers*, Cole (2009) examines patterns of lithic economic change across the Middle-to-Upper Palaeolithic transition, comparing in particular Châtelperronian and Aurignacian assemblages from three sites of the Périgord region of Southwest France – La-Côte, Caminade Est, and Le Flageolet I. The article is primarily concerned with issues of raw material 'economisation' and sets out to identify the specific behavioural strategies adopted in varying contexts to respond to these problems. Cole (*ibid.*: 128-131) departs from a general body of evolutionary and ecological theory to highlight the 'adaptive significance' of varying strategies of lithic raw material acquisition and conservation, as well as their differential 'efficiency.'[489] From these general considerations, he derives three hypotheses linking particular economic concerns to particular observable consequences (**Fig. 26**). These enunciations are purely theoretical and the goal is to pinpoint correlated economic and lithic variables to predict assemblage-level patterns that can be tested against empirical data. The basic rationale of this approach is to use the predicted patterns as a baseline to back-infer the correlated economic strategies. The author (*ibid.*: 131-133) discriminates between the 'blank portability hypothesis,' the 'distance attrition hypothesis,' and the 'mixed strategy hypothesis'; each of the three represents a different generic solution to the problem of raw material economisation in high-mobility settings, i.e., the fact that lithic raw material is finite and potentially has to be carried around in different formats. Cole (*ibid.*: 133f.) uses dimensional data and diversity estimations[490] to assess the overall size difference between artefacts made from local and nonlocal raw materials, the difference between tool and blank size in these two groups, and the difference in diversity between the two. All three hypotheses project distinct combinations of signature values for these three respective lithic variables.

The first hypothesis, the 'blank portability hypothesis,' describes a tactic of lithic raw material acquisition and conservation revolving around the planned transportation of high-quality raw materials (Cole 2009: 131). This tactic consequently entails the intense reduction of selected raw materials and a heightened anticipation of raw material needs. Therefore, (i[1]) non-local raw materials are expected to be smaller sized, (ii[1]) there should be no significant difference in blank size when local and non-local raw materials are compared, and (iii[1]) non-local raw materials should be generally less diverse.

The second hypothesis, the 'distance attrition hypothesis,' represents a raw material management tactic grounded in the principle of tool curation (Cole 2009: 132). This tactic implies the differen-

[487] It is noteworthy that there is a long tradition of thinking about stone tool technology as *extended phenotype* (*sensu* Dawkins 1982) – as the effective extension of the hominin body ((Washburn 1959: 30, 1960; Leakey 1971; Foley 1987; Schick and Toth 1993; Foley and Lahr 2003; Kelly 2016: 29; Shea 2017b: 39-42). This conceptualisation – the 'prosthetic view' of technology – not only abets the direct selection of technology-hominin couplets, but naturally evokes the idea of 'phenotypic plasticity' in the context of lithic technology. Toth and Schick (2009a: 299), for example, explicitly speak of lithic tools as "synthetic organs" and refer to the nature of technological evolution as "techno-organic."

[488] Bunge (2013: 590) explicitly lists Darwinian evolution as an example of mechanistic explanatory system relying on "nonmechanical" mechanism.

[489] See also Steenhuyse (2007: 11-24).

[490] Additional lithic data include lithic weight data and estimations of reduction intensity (e.g., ratio of retouched versus unretouched blanks per raw material unit).

tial treatment and transportation of retouched and unretouched lithic artefacts. As a result, (i²) there should be no overall size differences between local and non-local raw materials, (ii²) the size difference between tools and blanks is expected to be less pronounced in non-local raw materials, but (iii²) local and non-local raw materials should be similarly diverse.

The third hypothesis, a mixed strategy that combines elements of the previous two tactics, specifies an approach to raw material economisation in which both differential raw material transportation and tool curation plays a role (Cole 2009: 132f.). The strategy therefore implies both the selected treatment of certain raw materials and a focus on the raw material potential of tools. In this scenario, one can expect that (i³) lithic artefacts made from non-local raw material are generally smaller, (ii³) the difference between tool and blank size is higher in local raw materials, and (iii³) non-local raw materials should be less diverse (*ibid.*: Table 9.1).

Based on the juxtaposition of these test implications with the dimensional data and the diversity measures derived from La-Côte (level III), Caminade Est (level G), and Le Flageolet I (levels XI and IX), Cole (2009: 134-139, 140) argues that the encountered lithic patterns provide evidence for a general increase in technological efficiency in the timeframe between 38 and 32 kya in the Périgord region. This conclusion is based on the recognition that different economic strategies appear to be reflected in different lithic assemblages. Whereas La-Côte level III does not conform to any of the test projections and therefore appears to indicate a 'neutral' strategy or, alternatively, socioeconomic conditions under which economisation proved unnecessary, Caminade Est level G reveals a strategy in which blank portability was a major concern but the differential modification and reduction of blanks was apparently not important (cf. Cole 2002). The lithic signature of Le Flageolet I level XI, by contrast, suggests raw material economisation in terms of portability and distance attrition (Cole 2009: 140). The chronological sequence of these economic strategies signals that raw material economisation became an increasing concern across the Middle-to-Upper Palaeolithic interval. There is both a trend of strategic 'formalisation' and 'diversification.' Although Cole (*ibid.*: 128), in classic mechanistic fashion, proclaims that he

> "[...] is aware of no scientific theory that would predict an increase in the efficiency of [sic!] hunting and gathering throughout the Pleistocene without reference to any causal factor,"

he is ultimately hesitant to announce a 'law of progression' or a general 'evolutionary principle' of increasing economic efficiency. The circumstance that he sympathises with this idea, however, shows the felt necessity of linking 'pattern' to 'process' and to specify a general *mechanism* to account for the lithic observations (Cole 2009: 128f.).

There is another mechanism, however, which the author tacitly entertains, and without which his analysis would fail. This principle is a generalised version of *rational choice*. For his theoretical projections of the three generic tactics of raw material economisation with special attention on optimising technological 'efficiency' to be valid, it is required that the respective hominin players can be conceptualised as rational players. In fact, their economic rationality must be comparable to the rationality of the community of analysts since otherwise the projection of economic rationality is seriously hampered. Having said this, Cole's (2002, 2009) hypotheses about strategic behaviour and lithic raw material economy clearly entail rational conjectures on how one would manage lithic artefacts given particular strategies. The kind of economic rationality that he presumes, moreover, is technology-neutral, that is, independent of the respective technological systems adopted by hominins at the time.[491] Only then is it viable to assess issues of 'economisation' based on a fixed set of variables. Whether the author believes that *economic behaviour* and *technological behaviour* are to be separated since the former represents a more 'basic' category of reality, whereas the latter delineates a 'derived' category regulated by the first category must remain open, yet would at least be consistent with the pursued line of reasoning. The key point is that 'rational choice theory' (cf. Robbins 1932; Becker 1976; Cashdan 1990; Binmore 2009; Chibnik 2011: 2-5), even though not explicitly elaborated on, provides the set of fundamental mechanisms needed to study economic behaviour in the Upper Palaeolithic by

[491] As we will see in the subsequent chapter, this conceptualisation is heavily disputed by French technologists who regard economic organisation as critically *dependent* on the infrastructure of technology (see esp. the first part of Chapter 5). Beyond the larger world theory differences, we may also understand this divergence as local resurfacing of the 'substantivist-formalist debate' in economic anthropology (cf. Eriksen and Nielsen 2001: 83-85; see *infra*).

similar means as one would study such behaviour in the present.[492] Cole's *Technological Efficiency* is the study of *homo economicus* in the deep past. As Kliemt (2013), for instance, points out, *homo economicus* furnishes a 'model' of economic behaviour emphasising 'opportunity-taking rational action' and revolving around future directedness, insofar as individuals need to distinguish between what is and what is not a causal consequence of each of their actions and decisions taken separately, case-by-case motivation, and subjectivism, i.e., methodological individualism; it is the 'consistency assumption' underpinning this model (*idem*) that provides the kind of generalised mechanism required to place *Technological Efficiency* on firmly mechanistic grounds.[493] This invariable rationality principle is the precondition for the type of predictive reasoning adopted by the author.

Blades' approach to Aurignacian technoeconomics at La Ferrassie

Blades' paper *Aurignacian Core Reduction and Landscape Utilization at La Ferrassie, France* (2009) argues that the lithic economy evidenced in the Aurignacian layers of La Ferrassie in the Dordogne region can be explained as a response to changing ecological conditions in the vicinity of the site (esp. *ibid.*: 194; cf. Blades 1997 [2001], 1999). The ecological backdrop of the site is defined as the co-variation of climate regime and animal ecology which, in tandem, are regarded to have affected the structure of neighbouring animal communities and therefore the availability of potential prey species. Blades' approach is rooted in the *heteronomic assessment* of lithic patterns with respect to the local ecological circumstances into which they are 'inscribed.' The lithic patterns retrieved from the diachronic Aurignacian record of La Ferrassie are *externally related* to the available ecological data in order to isolate significant correlations. The author's general strategy is to derive reliable proxies for each of the two domains – lithic economy and human ecology – and to juxtapose them.

As a proxy for lithic economy he uses 'core reduction intensity' which he measures in terms of relative core-length(s) (Blades 2003, 2009: 191). Human ecology, by contrast, is approximated by the diversity and composition of the faunal assemblages documented in the Aurignacian layers (K6-l1) of the site. Since varying climatic conditions are expected to support differentially packed animal and mineral resources in the immediate surroundings, the structure of the local animal community can be taken as a rough proxy for the general ecology of the site.

The author then simply evaluates the two proxy measures in terms of patterned co-variation (Blades 2009: Figure 13.1, 13.3). He finds that core-length values appear to vary as a function of colder versus warmer climate regimes (*ibid.*: 191). The determination of colder climates in the earlier phases is based on the association with reindeer-dominated faunal assemblages, whereas the later Aurignacian phases are characterised by a more diverse (bison, horse, deer) faunal composition (*ibid.*: 191). Cores are on average shorter in the earlier phases of the Aurignacian (K6-K4) which the author inter-

[492] Cole's (2009) approach therefore resonates with the often-cited assertion by economist Becker (1976: 14) that "[…] all human behavior can be viewed as involving participants who maximize their utility from a stable set of preferences and accumulate an optimal amount of information and other inputs in a variety of markets." The emphasis here lies on *all*; economic theory is thought to provide a universal set of regulatory principles to study human behaviour across time and space, independently of its context or history. The principles that guide economic action and decision-making are considered *invariable* – they have the status of mechanistic 'principles' or 'laws' (cf. Chapter 2: **Box 7**).

[493] Arguably, Cole's (2009) approach, as most other approaches that can be grouped under the labels 'behavioural-strategic' and 'organisational' (see *supra*), is firmly rooted in the 'formalist' tradition of economic anthropology. 'Formalists' are usually opposed to 'substantivists' since the so-called 'formalist-substantivist debate' is a major date in modern anthropological discourse (cf. Eriksen and Nielsen 2001: 83-85). This debate was about the nature of economy and whether it can be studied as self-sufficient domain of human life, propelled by economic principles and law-like regularities. 'Formalists' have tended to adopt this view and argued that economy can therefore be studied by the same means and guided by the same assumptions in any context, past or present. 'Formalism' in economic anthropology has emphasised quantitative approaches and 'rational choice theory.' Inquiry in this tradition has typically focussed on *pragmatic strategies* and sought to demonstrate that *utility maximisation* plays a role in any human society (cf. Leclair and Schneider 1968): "[i]f we recognize that a difference of degree rather than of kind exists between most of our economic institutions and those of other peoples, the unity of the data concerned with the problem of economizing must be apparent" (Herskovits 1952: 42). Firth (1939, 1967), Schneider (1964, 1974), and Herskovits (1952), for example, were some of leading 'formalists' of their time. 'Substantivism,' by contrast, holds that economy cannot be studied as an independent phenomenon; it is always *embedded* in sociocultural practice and hence a product of human cultural life. As a result, not all human economies can be studied by the same means or in the same way, and there are serious epistemological preconditions of understanding them properly. 'Substantivists' have for example variously argued that modern economic concepts such as 'risk' and 'time-budgeting' are often not applicable to tribal or prehistoric societies, simply because these people do not necessary shared this concept. 'Substantivism' favours a qualitative and ultimately interpretive approach to economic organisation. Prominent 'substantivists' are for example Polanyi (2001 [1944]), Dalton (1961, 1969), and Bohannan (1955, 1959), but also scholars such as Sahlins (1972) and Godelier (1999). The 'substantivist-formalist debate' has lost much of its former heat in recent years but remains largely unresolved.

prets as evidence for an overall more intense lithic reduction (*ibid*.: 191, 194, Figure 13.1; cf. Blades 2003). Thus, the cores of the later and slightly warmer Aurignacian phases (K2, J, l3-l2) are on average longer. Complementarily, these are interpreted as less reduced (Blades 2009: 194). Blades (*ibid*.: 188-190) adds that the treatment of cores in terms of scar directionalities and platform configurations remains complex and mixed throughout the entire sequence and that there is thus no reason to believe that core technology *sensu stricto* is an important developmental factor; he (*ibid*.: 190) explicitly stresses the 'importance of a reduction continuum' in this regard.

Based on general considerations from evolutionary ecology, Blades (2009: 191, 193) establishes a theoretical link between 'reduction intensity' and mobility strategy, that is, foraging radius. Since core reduction intensities can be taken to reflect relative raw material consumption and therefore represent a measure for the 'economisation' of stone, they can be related to the frequency and character of hominin movement(s). The author (*ibid*.: 191) asserts that this, in turn, seems to suggest that

> "[...] the longer cores during the later Aurignacian occupations may mean that groups travelled shorter distances from quarries, had more regular access to quarry locations, and/or moved more frequently from the shelter to other locations without transporting the cores."

The exact inverse relationships can then be projected for the group of shorter cores, which appears to indicate longer travel distances from raw material sources, less regular access to these sources, and/or more frequent moves from campsites to other localities without necessary transporting the cores.[494]

Blades (2009: 192, 194) concludes that Aurignacian lithic technology at La Ferrassie reflects changing economic strategies tied to differential mobility and prey exploitation patterns. These strategies seem to have been structured by the prevailing climatic regimes. Core length is seen to record 'economising' behaviours related to 'adaptive' requirements. These conclusions are consistent with the author's earlier work, which essentially finds the same relationships based on a number of additional lithic variables such as tool retouch intensity and blank weight (cf. Blades 1997, 1999). Altogether, the adopted cognitive strategy is clearly mechanistic. Not only is knowledge established and corroborated by causally adjusting selected technological variables and ecological parameters, the reconstruction also reveals a clear-cut 'chain of inference' predicating the environment-subsistence-mobility link as the basal layer of determination. Again, behaviour is understood as a systemic phenomenon with its unique 'field of locations,' so that the individual lithic assemblages from La Ferrassie can be recognised as relative parts constrained by the other working parts of the total machinery. Basic economic principles are ultimately responsible for rendering the machine a *viable* one. Blade's (2009) study is also notably 'integrative' insofar as it mobilises only a handful of variables to determine the overall character of the adaptive system. This not only underlines that these factors are identified as causally relevant but also shows that *ordered causation* – in the sense of a 'directed chain' – and its 'specifity of response' are taken for granted.

[494] Note that the inference of travel distances relies on a general *distance-decay* model assuming that raw materials diminish with increasing distance from the point of origin (see *supra*). This model, as we have seen, is inherently 'mechanistic' (see the first part of this larger section).

Chapter 5

Syntheticity unpacked: French approaches between contextualism and organicism[495]

"[...] *I deliberately dismissed the path of functional typology. It is for the lack of data on the behaviour of prehistoric men based on their activities with their tools, for the lack of power, at least at the moment, to discern the intentions of use, that I devoted myself to grasping the intentions of knapping instead.* [...] *For a term to be precise and unequivocal, it must contain in itself the intention of the craftsman who has knapped a prehistoric tool.*"

– Jacques Tixier (1978 [2012]: 115, 117; my translation)

"[...] *Every society therefore comes into view first and foremost through the features of its adaptation to its environment. But this notion deserves to be properly evaluated: it signifies, in our opinion, the adaptation to particular natural conditions mediated by social prerogatives acting according to an internal dynamic. In this sense, these natural constraints operate only on the bark of a society, and not on its core. Thus, the preference of privileging a more or less collective approach to hunting, to promote technologies which allot hunting equipment a more or less prominent place, both respond to social imperatives that are independent of the conditions of the natural environment. In the same way, it is never the environment that imposes on a human group the need to become a farmer or a shepherd, but it is the proper evolution of man and his societies that may lead to it. Admittedly, the environment can hinder or promote such a behavioural transformation, but it does so in a passive manner. It is in this sense that the environment is not a cause but a means of this evolution. The technological and economic expressions of a culture thus reveal an "alloy" of external and internal determinants perfectly independent of one another.*"

– François Bon (2009: 243; my translation)

Abstract

This chapter analyses a range of case studies drawn from French lithic inquiry and investigates whether research in this tradition can be organised into 'contextualistic' and 'organicistic' strands. The structural categories of the respective two world theories are employed in order to demonstrate that this is indeed the case. Four cases of 'contextualistic' inquiry and three cases of 'organicistic' research are identified and discussed in detail. 'Contextualistic' trends in the French scene make use of Pepper's categories of 'texture' and 'quality' in order to interpret the lithic evidence. These perspectives, including traditional *chaîne opératoire* research, stress the 'relational' constitution of lithic data and insist on the 'context-dependency' of both data and findings. French strands of lithic 'organicism,' by contrast, seek to resolve what they identify as 'fragments of experience' by placing them into meaningful 'nexuses.' It is shown that the respective approaches place heavy emphasis on the 'conflict-driven' and 'heterogeneous' character of reality, as well as on the 'stage-mediated' nature of organic processes. Pepper's framework therefore greatly enhances our understanding of the epistemological orientation of French technological research. It also reveals that the French lithic inquiry cultivates a 'whole-centred' approach.

If French lithic research in Palaeolithic archaeology exhibits a strong 'synthetic' conviction, we would expect that the main research trends can profitably be described in terms of Pepper's relatively adequate 'synthetic' world theories – 'contextualism' and 'organicism.' Like in the Anglophone case, successful reconciliation between the key features of French lithic inquiry and Pepper's 'synthetic' theories can therefore explain (i) why even counteractive forces in the French scene are able, *grosso modo*, to meaningfully interact with one another and coevally demonstrate that (ii) lumping French lithic research into a single higher-level category makes sense, at least when it is contrasted with Anglophone

[495] The French original of the opening quotes are given in **Appendix Q.8** and **Q.5**.

inquiry. Arguably, the characterisation of French lithic analysis as the dynamic interplay between 'contextualistic' and 'organicistic' modes of thought helps to unearth some key aspects of the cognitive peculiarity of the French tradition, including its distinct ways of marshalling and interpreting lithic evidence.

In the two parts that follow, I will first break down four exemplary cases of 'contextualistic' research in the French scene and then present three symptomatic examples of 'organicistic' reasoning therein. Again, these examples consist of a combination of individual case studies and larger discursive formations. These cases are taken as paradigmatic of French lithic inquiry (see **Appendix III.4** for a detailed discussion of case study design and selection).

5.1 **Tropes of contextualism in French practice**

5.1.1 ***« Lecture », mental refitting, and schémas diacritiques***

Certain operational cornerstones of *chaîne opératoire* analysis (Brézillon 1968; Tixier 2012 [1978], 1980) and of the 'technological approach' in general (Tixier et al. 1980; Pelegrin 1988, 1990; Perlès 1991a; Inizan et al. 1999 [1995]) provide a direct entry point to modes of contextualistic inquiry prevalent in the French tradition. I will first reiterate some key features of contextualistic thought, and then show how these features can be retraced in French technological research.

The key category of contextualism is *context-dependency*, or the *situatedness* of collectable facts in the world. To recall, qua 'synthetic' world theory contextualism presupposes that contexts have interpretive priority over facts (parts) and legislate on how they are to be connected; parts, in the view of contextualists, are fundamentally dependent on their wholes and thus necessarily 'whole-endowed.' It is the *unity* of facts that requires the most attention according to contextualism.

Two regulative ideas guide the contextualistic enterprise of mapping varying contexts in their complexity and diversity: (a) *polyvalency* – the dogma that the same facts may have a fundamentally different meaning when they appear in different contexts – and (b) *inter-action* – the idea that facts are connected by relations and that these are always to be regarded as, minimally, bidirectional affairs.[496] The latter specifies the belief that connections between facts cannot be carved out or found in the facts themselves, but can only be elucidated by returning all facts into their original context. The root metaphor of 'situationality' thus generally motivates scholars to study the world in its radical *relationality*, as a web of interconnected nodes (parts) framed by a context (whole). It is possible to show that these two interpretive notions – 'polyvalency' and 'inter-action' – are directly reflected in how lithic technical systems and/or *chaînes opératoires* are studied by French technologists.[497]

French practitioners typically identify relations among lithic artefacts, techniques, and technical processes in a well-defined assemblage context as the basal units of analysis (e.g., Tixier 2012 [1978]: 32; Pelegrin et al. 1988; Valentin 2011: 111). Instead of concentrating primarily on discrete artefact traits, attributes, and/or other 'atomistic' measures, scholars try to understand how lithic objects relate to one another and what sorts of connections explain why specific objects and object-groups can be found in their respective lithic assemblage(s) (cf. Valentin 2011: 80f.). The granting of epistemic primacy to *qualitative* and *relational data* is a result of this general research configuration (cf. Tixier 2012 [1978]: 67; Perlès 1987; 1991a; Boëda 1988, 1994); it is a deeply built-in feature of what is commonly referred to as the 'technological approach' in France (e.g., Tixier 1980; Tixier et al. 1980; Perlès 1987, 2016; Boëda et al. 1990; Geneste et al. 1997; Bon 2002; Bourguignon et al. 2004).

Indeed, the objective of technological research in this tradition is to reconstruct 'technical systems' which are defined by the articulation of physical objects (lithics), techniques, methods, concepts, corpora of knowledge, and bodily gestures (cf. e.g., Pelegrin 1988; Geneste 1991; Boëda 1991; cf. Chap-

[496] I deliberately use the spelling 'inter-action' here to emphasise the concept that 'action' takes place in-between two or more action-givers. Interaction is thus not interpreted as correlation, co-variation, or as a 'tie'-relationship as in 'formism' or 'mechanism,' but instead as a co-constitutive relationship potentially changing the status of the involved action-givers themselves. Interaction in 'contextualism' is a dynamic relation that informs the functioning and character of the whole. It may in fact be highly telling that some French lithic specialists also prefer to use this particular spelling (Ploux 1988; see quote *infra*).

[497] The strong emphasis that French scholars typically place on the idea of a 'technical system' is illuminating (cf. Geneste 2010 [1991]: 421-424; Soressi and Geneste 2011); this notion signals that *systemic articulations* are regarded as the key features of lithic technologies and that it is ultimately their 'wholeness' which defines them. Approaches that reconstruct lithic technical systems in this manner are 'synthetic' by definition.

ter 3)[498] – and hence by the various ways in which these heterogeneous factors *inter-act* with one another to form integrated technical wholes (Inizan et al. 1999 [1995]: 14). A 'technical system' in this sense is always characterised by the 'interpenetration' of observable and deducible facts – a structural category proper to contextualism:

> "[...] Each of the artefacts featuring in the same assemblage has potentially a different fate. This situation proves the opportunity to recognise the inter-actions between each technical process – at best identifiable from a sidescraper whose micro-traces indicate skin-working, a burin which served to work animal antlers, etc.– and each technical chain. [...] In reality, however, a multitude of modalities is envisageable, depending on whether the nature or plan of inter-action establishes a correspondence between a process and one or more chains, whether or not each chain participates in multiple processes, or whether the same artefacts successively take part in several processes within the same operational sequence, either in the same physical form [blank] or after transformation [tool]. At the scale of assemblages, the entirety of these modalities or only certain ones may be represented, illustrating strongly different behavioural attitudes towards the organisation of technical activities. The importance of this type of information has already been emphasised multiple times [....]" (Ploux 1988: 39; my translation [for the original French quote, see **Appendix Q.9**])

It follows that each of the elements participating in a technical system potentially co-shapes any other element; description of the whole therefore requires the specification of the entire web of 'co-constitution.'[499] The classic strategy with which to approach this problem is the study of technical wholes from three interrelated perspectives – these perspectives are sometimes re-cast as complementary 'levels of analysis.' Technical wholes, accordingly, can be defined by their (a) 'structure' (*structure*); their (b) 'operation' (*fonctionnement*); and their (c) 'function' (*fonction*) (see Sigaut 1991, 2012: 52-54; cf. Geneste 2010 [1991]: 423f.; Valentin 1995: 16, 24; Soressi and Geneste 2011: 337).

'Structure' thereby refers to the specific arrangement of sub-units that make up a technical whole (see e.g., Boëda 1991: 40f.). These sub-units are often identified as sub-structures or sub-systems and respond to the question 'what is it?' and 'what does it consist of?' (Sigaut 2012: 53); 'structure' thus defines the whole as it formally comes into view if inspected from an external perspective. The category of 'operation' addresses how the technical whole functions internally (*idem*); it responds to the question 'how does it work?' and consequently seeks to provide a dynamic description of internal processes, movements, and/or relations insofar as they help to clarify the role and status of the various parts or sub-units of the system.[500] This category is crucial and seems to be quite specific for 'synthetic' interpretations of lithic technology. 'Function,' finally, defines the finality or goal-directedness of a technical whole; it responds to the question 'what is the point of all this?' and generally theorises the effects of the internal organisation (interplay between 'structure' and 'operation') (*idem*). This latter category defines how the whole is externally-related – for instance, its place and role within a larger 'super-structure.' The category thus helps to recognise the function of a whole in an even larger whole, explaining why technical systems are regularly re-cast as sub-systems of broader socio-economic formations (e.g., Perlès 1987: 22; Geneste 2010 [1991]: 423; cf. Inizan et al. 1999 [1995]: 14).

This tripartite conception of 'technical systems' can be clarified considerably with the help of Pepper's structural categories of contextualism: the 'structure' of a technical whole and its mode of

[498] This conceptualisation of 'technical systems' is inseparable from the historical formation of the 'technological approach' in France and *chaîne opératoire* research in general (e.g., Karlin 1991; Perlès 2016). It represents the coalescence of several potent strands of research, most notably of what is sometimes called 'Anthropology of Techniques' and the 'History of Techniques.' The former, also known under the label *technologie culturelle* (cf. Bensa 1996), was instrumental in bringing forth *chaîne opératoire* theory and methodology. It was spearheaded by Robert Cresswell (1983, 1994, 2010) and Pierre Lemonnier (1976, 1983, 1986) and led to the establishment of *Techniques & Culture*, a platform for interdisciplinary research into human technicity (cf. Roux 2013: 27). The second strand of inquiry, based on the disciplinary legacy of history and sociology, is represented by Bertrand Gille and his seminal *Histoire des techniques* (1978), perhaps with the addition of Jean Baudrillard's (1968) *Le système des objets*. The 'systemic' conception of technology itself is probably even older, having already made its way into French Palaeolithic archaeology through the work of Gilbert Simondon (1958) and others. Systemic thinking is since then an irreducible ingredient of French technological thought (cf. Séris 1994; Lemonnier 2012).

[499] This accounts for the 'contextualistic' belief that we can only presume that nothing can be presumed – which is simply to say that there can be no fixed categories on which one can confidently base all inquiry independently of the character of the context in question (see Chapter 2 for details).

[500] Again, the term 'dynamic' is not innocent here; a dynamic description is nothing less than a description that takes seriously the genuine and differential contribution of *all* elements that make up the technical whole. To regard technology as a 'dynamic system' in this sense reiterates the 'contextualistic' conviction that nothing can be 'absolute' and everything must consequently be context-dependent (see *supra*).

‘operation’ delineate the key aspects of the specific ‘texture’ of a technical system (or context) – that is, its ‘technological architecture’ – whereas the interrelationships between ‘structure,’ ‘operation,’ and ‘function’ provide insight into the ‘fusion’ of the texture-giving elements – i.e., how the ‘infrastructural’ features come together – thus clearing the view for the immanent ‘quality’ of the whole. Taken together, the three categories thus provide the contextualistic frame of reference in which technical ‘inter-action’ can be meaningfully examined. To study the ‘spread’ of the ‘quality’ of a technical whole among its texture-giving parts then simply means to isolate distinct sub-units of ‘inter-action’ and to expose their spatiotemporal organisation (cf. Pelegrin et al. 1988):

> “[…] [The] unfolding [of the *chaîne opératoire*] presents itself as an enchainment of different means organised in time and space, so that the technical chain can be broken down into several spatiotemporal operational sequences.” (Ploux 1988: 41; my translation [for the original French quote, see **Appendix Q.9**]).

This implies that even the categories of space and time are interpreted from a contextualistic vantage point. They are seen not so much as the dimensional axes of a predefined ‘Newtonian’ space-time grid, but as context-dependent variables themselves. Space and time are re-cast as whole-categories that help to illuminate the articulation of objects and processes – they make sense as interpretive categories only if they facilitate the ordering and grouping of the encountered technical relations.[501] This typically results in the identification of spatial and temporal features which are specific to distinct technical contexts; a predisposition that paves the way for the recognition that different *chaînes opératoires* bring forth distinct spatio-temporal matrices. This fact simply reflects the contextualistic conviction that ‘quality’ is spread out differently in dissimilar technical wholes.[502]

It should not be surprising, then, that the temporal unfolding of a *chaîne opératoire* (*« déroulement »*) depends entirely on its organisation (e.g., Geneste 1985: 170, 178-183) – i.e., how many stages are distinguishable, how many kinds of gestures, techniques, and technical objects participate in a single stage (including their own temporalities), whether and when the technical chain branches off into various sub-chains, and so forth (Pelegrin 1988; Bourguignon et al. 2004; Rocca 2013; **Fig. 27, 28**). Similarly, each technical whole typically brings forth its own distinctive spatiality – that is, a specific pattern of how the various parts of a ‘technical system’ arrange themselves in space (cf. Boëda 1993; Delagnes et al. 2007, 2012). This spatiality can be understood in ‘volumetric’ (e.g., Boëda 1994; Pelegrin 1995; Bourguignon 1997) or ‘geographic’ terms (e.g., Geneste 1985, 1988; Julien and Rieu 1999; Audouze 2006; Delagnes 2010; Mevel 2010; Valentin et al. 2013), depending on the scale of analysis and the ‘technical system’ in question. The fact that key differences between varying lithic technologies or technological conceptions are generally described as disparities in the ‘volumetric organisation’ of reduction processes gives voice to this interpretive matrix (cf. Valentin 1995: Annexe [Première Partie], 2011: 17; **Fig. 29**).[503]

All of this highlights a certain *relativity* of the spatial and temporal characteristics of a ‘technical system,’ a relativity that is distinctive for contextualistic reconstructions. Moreover, the amenability of spatial and temporal determinations to change and their requirement for context-sensitive

[501] This demarcates a key difference between French *chaîne opératoire* approaches (COA) and the classic Anglophone ‘reduction sequence’ approach (RSA). RSA typically presumes dimensional time and thus draws lineal artefact-consequences from the passing of time, e.g., that artefact dimensionality/size diminishes and/or cortex ratios decrease; the space-time is a constant is conceptualised as given, so that its particular effects can be measured in individual artefact characteristics. The direction of inference is *upwards*, from dimensional time to specific artefact features. COA, by contrast, generally draws spatiotemporal conclusions (staging of technology, reduction depth etc.) from the organisation of the encountered artefact totalities; the spatiotemporal structure of technology is reconstructed in a *downward* direction, following from the nature of the technical system.

[502] We can therefore say that different technical wholes typically possess distinct *temporalities* of ‘operation’ and procedural presence/ongoing.

[503] Almost the entire range of new technological definitions and/or re-definitions of long-standing ‘industrial’ complexes that were proposed after the ‘technological revolution’ yielded *volumetric definitions* of lithic reduction systems. Examples are the various methods and modalities of the Levallois concept (Boëda 1986, 1988, 1993 1994), the ‘Clactonian’ method (Forestier 1992, 1993; Amiot 1993), the Châtelperronian (Pelegrin 1995; cf. Roussel 2011), the Discoid conception (Boëda 1993; Jaubert 1993; Mourre 2003), Quina technology (Bourguignon 1996, 1997), the MTA (Soressi 2002), the Early Aurignacian and Protoaurignacian (Bon 2002; Le Brun-Ricalens and Brou 2003), the Badegoulian (Cretin 2000) as well as smaller-scale technical entities such as the ‘Pucheuilian’ (Delagnes 1993), the ‘Orvillian’ (Perlès 1977, 1982), the ‘Belloisian’ (Valentin 1995), the ‘Néronian’ (Slimak 2004, 2007), or the ‘Hoabinhian’ (Forestier 2000, 2010). More recent work on lithic technology follows a similar lead (e.g., Klaric 2003; Teyssandier 2003; Montoya 2004; Boccaccio 2005; Faivre 2008; Renard 2010; Langlais 2010; Ducasse 2012; Mevel 2017).

analysis are direct consequences of the 'polyvalency' condition;[504] this enshrines the conviction that lithic artefacts without context are incapable of unambiguously informing us about their volumetric and/or temporal position (chronology, core geography, reduction stage, etc.) in a technical process. In this way, each lithic artefact comes into view primarily as a spatiotemporally 'situated' part, the informational value of which depends completely on our ability to determine its relative place in the technical context to which it belongs.

This pervasive 'polyvalency' of physical forms culminates in the conception that the same lithic shapes and even the same groups of artefacts might recur in different technical contexts even though their technological role, status, and/or signification may differ vastly across these contexts (cf. e.g., Coudenneau 2013: 300-307; **Fig. 30**). The prototypical example of the application of this logic of reasoning is that of the Levallois point (*« pointe à Levallois »*) (e.g., Boëda 1986: Fig. 177, 1991: Figure 6, 2013: Figure 84; Texier 1995; Mourre 2003; Bourguignon and Turq 2003; Locht 2004; Goval et al. 2016). Boëda (1986) has summarised the dilemma as follows:

> "The Levallois point may result from different knapping conceptions, which a determination by simple typological means cannot bring to light. Only the technological analysis of the knowledge used to realise it can reveal the potential variability of the volumetric conceptions of cores and the methods that result from it." (*ibid.*: 263; my translation [for the original French quote, see **Appendix Q.10**])

According to this general assessment, different systems of handling a volumetric core-matrix during blank exploitation have the potential to produce objects that look like Levallois points.[505] A striking example is the Discoid *débitage* system, which cyclically produces so called 'pseudo-Levallois points' when the core convexities are rejuvenated (Boëda 1993, 1995a; Mourre 2003). Several 'pyramidal' structures of blade extraction, especially simple convergent methods, similarly yield triangular blanks, slightly elongated or not, that *prima facie* appear to be Levallois point-like (cf. Coudenneau 2013: 300). It follows that the mere presence of objects resembling Levallois points in a lithic assemblage is not sufficient to identify with certainty the technology of which these objects are a product.[506]

Only a detailed 'map' of intra-technological relationships is thought to provide researchers with the means to determine the technological implication of similar-looking lithic objects, even as they appear across different technical contexts.[507] The general idea, typical for contextualism, is that while forms do not fully determine their context, contexts *constrain* the quality and frequency of the total range of forms they host; the resulting multipolar and multidirectional determination of lithic artefacts through significant wholes is a characteristic facet of contextualistic thought.[508]

Returning the totality of lithic pieces to their technical context(s) ultimately requires the solution of a '4D' puzzle (cf. Valentin 2008a: 285) – the reconstitution of the volumetric and temporal position of each three-dimensional lithic object in its technical system (Geneste1985; Boëda 1994;

[504] The cognate concept of 'polysemy' is for instance employed by Valentine Roux (2013: 18f.) to describe this condition. For an explicit use of the term 'polyvalency' in lithic research, see Coudenneau (2013: 300-307) who distinguishes three different variants of lithic polvalency: (i) polyvalency of functions (*polyvalence de fonctions*); (ii) polyvalency of forms (*polyvalence de forms*); and (iii) polyvalency of productions (*polyvalence de productions*).

[505] It is also clear that the potentials are not the *same*. But the significance of these differences and their quantitative and qualitative effects cannot be known *a priorily*. It is for this reason that fact-based 'contextualistic' analysis becomes indispensible.

[506] This reoccurence of similar forms in different contexts is the basis for the 'contextualistic' critique on the 'formistic' root metaphor of 'similarity.'

[507] This effectively issues a plea for finding technical differences where similarity in forms prevails. In contrast to the management of 'equifinality' in 'formism' and 'mechanism,' the calibrating factors are viewed to be found in the *same domain of reality* – namely, in the technical domain. Similar forms might be instantiated by different contexts not because these contexts are similar, or at least driven by similar imperatives, but because the morphometric space of lithic reduction is limited and variability must thus be revolved *internally* – through the study of inter-actions and inter-relations.

[508] It is of course clear that contexts are rarely complete because lithic pieces have been removed in the past and/or because sites have only been partially excavated; this also generates a problem for 'contextualistic' inquiry but the problem is formulated differently than by other world theories. Part of this difference can be captured if we refer to the proposed distinction between 'semantically-orientated' and 'syntactically-orientated' archaeological research by Plutniak. According to Plutniak (2015: 44), the notorious incompleteness of the archaeological record can be conceptualised as an *incompleteness of the empirical data* which needs to be overcome by adequate epistemic techniques such as analogy and/or interpretation. As he puts it (*idem*), archaeology then becomes "mostly a way to get an understanding of the meaning of material remains and to draw a restitution of the past." This is what he calls 'semantic-oriented' archaeology. But incompleteness can also be regarded as an *epistemic feature of how we ought to construct archaeological arguments and knowledge*. This view is generally sceptical of too much interpretation and calls for a strict "control of archaeological enunciation" (*idem*). Archaeology in this view is regarded as "the study of the transformations of a set of artefacts over time" (*idem*). This is what Plutniak names 'syntactic-oriented' archaeology. It should be clear from what has been said thus far that the 'semantic' proclivity is more typical for French lithic research whereas Anglophone approaches tend to be more 'syntactic.'

Pelegrin 2005).[509] The puzzle is four-dimensional because three-dimensional objects – blanks, cores, preparatory elements, etc. – are pieced together to form larger three-dimensional *complexes* of objects (e.g., core sequences or burin-spall sequences). Yet, the puzzle metaphor is only partially adequate. Puzzling together lithic artefacts is rarely a straightforward or self-evident undertaking. Unlike puzzle pieces made from cardboard or plastic, lithic assemblages are notoriously incomplete and direct artefact-conjoins are therefore often the exception rather than the rule; 'physical refitting' is therefore generally difficult and cannot be expected to be a reliable, context-independent baseline of knowledge-production.

Additionally, 'physical refitting,' unfortunately, reconstructs above all the mechanical succession of artefacts and not necessarily, let alone automatically, the 'inter-actions' of objects and processes as they account for technological meaning (i.e. the systemic functioning of a technical whole). Moreover, if 'physical refitting' is possible, it typically leads to a fragmentary reconstitution of the technical spatiotemporal sequence(s) (*chaîne opératoires*) because there are always artefacts that have been exported from archaeological sites and the sites themselves are rarely excavated *in toto*;[510] this collides with the intrinsic ambition of French technologists to holistically reconstitute hominin technicity. The central issue is that 'physical refitting' remains naturally incomplete and thus almost always part-centric.[511]

If one wants to capture technical wholes, one therefore has no choice but to make sense of puzzle pieces which only imperfectly fit each other.[512] To respond to this problem, French technologists have devised two interpretive strategies – (i) 'mental refitting' (*« remontage mental »*) and (ii) technological 'reading' (*« lecture »*) (cf. e.g., Pelegrin 1986; Boccaccio 2005: 38). These two prisms of technological analysis unequivocally confirm that lithic research in the French tradition subscribes to the contextualistic project. They will be disentangled in the following to flesh out this point.

Technological 'reading' – or *« lecture »* in French – is the practice of deciphering technical stigmas and their interrelationships on individual lithic artefacts as well as to interpretively arrange objects in a technological space to understand their signification (cf. e.g., Inizan et al. 1999 [1995]: Chapter 6; Pelegrin 2005).[513] *« Lecture »* always has a dual significance: first, intra-artefact relationships are mapped in order to understand the character of the present artefact-wholes before, secondly, the artefact 'maps' determined in this way are related to other co-present artefact 'maps' in order to devise a comprehensive technological 'super-map' of all artefact inter-actions (cf. Pelegrin et al. 1988; Boëda et al. 1990).[514] This approach is *dynamic* since it requires an ongoing cross-adjustment of interpretive strands and scales within a cyclic structure of hermeneutic inference (cf. Chapter 3). Marie-

[509] Typically, the determination of the frame of the '4D' puzzle is part of the puzzle-solving: in practice, lithic assemblages are regarded as consisting of a number of sub-puzzles (sub-contexts) which are part of the bigger assemblage puzzle.
[510] The issue is of course aggravated when lithic assemblages are to be compared because the unstable success rate of 'physical refitting' threatens to undermine the comparability of different assemblages (if compared through the prism of refits); refits from different assemblages often provide different insights, are unequally complete, frequent, and/or technologically representative.
[511] This is another reason why refitted sequences are often used as parts and contextualised with other pieces of information to reconstitute technical wholes. 'Contextualism' thereby seems to have the somewhat unique capacity to cope with heterogeneous parts; relating partially refitted sequences with non-refitted lithic artefacts and their characteristics is regularly achieved in French 'contextualistic' lithic research.
[512] It is no mere coincidence that practices of 'mental refitting' (sometimes also denominated 'virtual refitting') are widely used to study animal bone assemblages (cf. Christensen 1999; Averbouh 2000); these are often highly fragmented and preservation renders bones per definition imperfect to conjoin. The method has therefore, rather ironically, been discussed more extensively in branches of zooarchaeology (e.g., Averbouh 2001).
[513] The deliberate use of the term 'reading' here can be seen as a tacit admission of the difficulty of the task. Not only is the problem of understanding lithic technology seen analogously to understanding a written text, the term also signifies that each piece must be inspected multiple times – it must be 'read' and 're-read' until intelligibility has been reached. This tacit analogy also points to a residual ambiguity of all reading procedures, no matter how refined they are. This is why technological reading is only the beginning of inquiry, not the end of it.
[514] The identification of parts and wholes is dynamic and may shift dependent on the problem context at hand. With regards to an individual object and its technological reading, the object is the whole and its features (scars, ridges, platforms, morphology, convexities, etc.) are the parts. When it comes to the reading of an assemblage, artefacts turn into parts and the assemblage itself becomes the whole. In reality, the situation is even more complicated since various intermediate categories of technological signification may be invoked to explain the overall variability of facts. Such intermediate categories can be different technical systems or modalities if the assemblage is too heterogeneous to explain the variability it hosts by reference to one single super-whole. Mousterian lithic assemblages are the prime example for the necessity of introducing intermediate wholes. These assemblages are thought to be the result of multiple co-occurring technical systems. In such a scenario, we are facing at least three levels of changing part-whole relationship and hence a truly nested structure of cyclical inference. The resulting reasoning process is unmistakably 'hermeneutic' in character (see Chapter 3).

Louise Inizan and colleagues (1999 [1995]) specify this general inclination in *Technology and Terminology of Knapped Stone* with respect to individual objects:

> "[…] it is necessary to go through the process of reading a stone object before attempting to study the lithic assemblage it belongs to. From the perspective of [a] technological study, a stone object, be it a tool or a waste product, is part of a technical operation, all elements of which are interdependent. Moreover, in such a perspective, the reading of an object brings into play the raw material used, as well as the technical actions and the knowledge, which together work towards the conception of the tool, in the broader sense of the term (tool, weapon, tool component…). It is therefore essential to have an in-depth understanding of the basic document, in the present case each lithic object of an assemblage, in order to enrich subsequent inferences." (*ibid.*: 89)

Practices of technological reading typically require engagement with the *schéma diacritique* of a lithic object (e.g., Boëda 1994: 21; Crassard 2007: Annexe 3.1). Reconstructing this *schéma diacritique* constitutes the methodological cornerstone of any *chaîne opératoire* analysis (Tixier 1978 [2012]: 121; Pelegrin 1995). The *schéma diacritique* is a simplified graphical representation of an object, which sets spatially distinct parts of an object into chronological relation (cf. Dauvois 1976: 195-201; **Fig. 31**). For the most part, this amounts to a contextualistic interpretation of 'reduction histories' as they are reflected in scar inter-relationships of particular lithic objects. In its most basic form, devising a *schéma diacritique* implies the study of truncations and overlaps between scars to distinguish groups of scars and to order them chronologically – it is an attempt to capture the spatiotemporal dynamics of working a lithic object (cf. Soriano 2000: Annexe 2 [411-413]; Crassard 2007: Annexe 3.4 [234-285]; Roussel 2011: Chapitre 5). It is no mere coincidence that this way of 'reading' object biographies co-developed with new ways of drawing lithic artefacts that emerged in the course of the 'interpretive turn' ushered in by Tixier and his followers (e.g., Inizan et al. 1999 [1995]: Chapter 7).

To embark on a *« lecture »* approach to understanding the organisation of lithic assemblages usually also means to plunge into practices of 'mental refitting' – *« remontage mental »* in French (Pelegrin 1986; Le Brun-Ricalens 1993: 134; cf. Inizan et al. 1999 [1995]: 90).[515] In the words of Jacques Pelegrin (1995: 23f., my translation):

> "[…] We must then call upon what may be referred to as *mental re-fitting*: the study of each lithic object, according to its morphology, the presence and position of cortex, and the order and characteristics of the negatives of removals (visible on both blanks and cores: observation of 'diacritical schemes') attested by a short preceding sequence, can enable, by mentally juxtaposing each object with all other objects and with the untreated blocks, the reconstruction of the specific systems of which the lithic objects are the outcome (an essential notion formalised by J. Tixier 1978).) Such a mental operation, which re-arranges the pieces in the three dimensions of space and according to the order of their detachment, allows one to access a "technical logic," for which a good practice in the study of collections is mandatory and which always profits from experience in knapping hard stones (cf. the *technological reading* of lithic pieces: J. Tixier et al., 1980, p. 35)." (original emphasis changed from bold to italics [for the original French quote, see **Appendix Q.11**])

'Mental refitting' always seeks to identify and retrieve technical relationships of co-constitution. It aims to elucidate how particular characteristics of lithic artefacts 'inter-act' to produce certain systemic technological outcomes. 'Mental refitting' therefore qualifies inter-artefact relationships that specify key technical consequences, morphological and/or technical complementarities, or specific 'logics of knapping' rather than to map artefact-centred similarities or correlations (cf. Perlès 1991a; Pelegrin 2005);[516] it implies nothing less than to mentally juxtapose and compare all artefacts in a given set of artefacts in order to find a well-defined spatiotemporal place for each artefact; the technical characteristics of each lithic artefact, in other words, must be interpreted in light of the characteristics of all other artefacts that are present in the assemblage. The procedure therefore practically relies on multiple and recurrent steps of sorting and pre-sorting an assemblage – 'mental refitting' gives voice to an *embedded mode of hypothesis-testing* (see Chapter 3). However, in contrast to 'physical refitting,' 'virtual' or 'mental refitting' only enables a general reconstitution of *chaîne opératoires*,

[515] This term already appears in Tixier's *Méthode pour l'étude des outillages lithiques* (1978 [2012]: 124), although the precise formulation he uses there is "mental reconstruction" (*« restructuration mentale »*).
[516] For the notion of 'technical logic' (*« logique technique »*), see e.g., Perlès (2009) and Chevrier (2012: 769f.). [See also Boris Valentin in [Devenir Archéologue] *Les outils en pierre préhistoriques*, available on YouTube (URL= https://www.youtube.com/watch?v=MB4CD145z40, uploaded on the 9.2.2016)]

without capturing subtle knapping details or intra-assemblage differences in lithic knapping performances (Ploux 1983).

The evaluative criterion for a successful *« remontage mental »* is a fairly pragmatic one: successful working.[517] 'Mental refitting' aims to specify constitutive technical relationships that 'work,' those that remove interpretive problems or the 'blocking' of 'strands' in Pepper's sense. This 'workability' is assured by disbanding any remaining inconsistencies within the proposed reconstruction of lithic technology in a given assemblage. 'Mental refitting' hence also showcases the 'dispersive' nature of *chaîne opératoire* research in France. Rather than to extract and to thereby pre-select artefact-traits to be examined, technological inquiry takes the artefact *as it is* and relates it to all other artefacts *as they are*.[518] The objective is to determine a set of 'inter-active' principles and a global organisational structure that, taken together, 'harmonise' as many object relationships as possible – this is the interplay between Pepper's (1942: 238) categories of 'texture' and 'quality,' both diagnostic for contextualism as an epistemic endeavour.

'Mental refitting' makes room for a hyper-'dispersive' approach to lithic facts. In the spirit of contextualism, it enables the effective integration of background experience and epistemic ready-mades such as individual knapping expertise or first-hand knowledge about other lithic assemblages. It urges scholars, for instance, to effectuate 'physical refittings' and to study them technologically – even if the thereby reconstructed sequences are naturally fragmented (cf. e.g., Cahen et al. 1980; Ploux 1988; Karlin 1991; Bodu 1993; Pigeot 2004; Julien and Karlin 2014). The reason is of course that 'physical refits' – if they inform about technology[519] – can be used as an additional layer of background information to enhance the interpretation of the observed facts (e.g., Delagnes and Roche 2005; Bachellerie et al. 2007; Delagnes et al. 2012).[520] This general focus on aspects of 'quality' and 'texture' of lithic technologies combined with a strongly 'dispersive' strategy of handling evidence unmistakably identifies this mode of reasoning as contextualistic.[521]

Last but not least, contextualistic inquiry in French lithic analysis aims to relate systemic 'inter-action' with technical practice and to discuss them both in their social and historical situatedness (e.g., Pigeot 2004; Schmider and Roublin-Jouve 2008; Audouze 2010). The assemblage context is recast as a reflection of its wider socio-historical context – lithic assemblages make accessible *« systèmes techniques »* which themselves take part in larger sociocultural systems (Perlès 1987; Valentin 2011: 114). Lithic assemblages are viewed as a context of objects as much as they are seen as a context of practices – of what can be termed 'technical *habitus*' (*ibid.*: 58). Therefore, technological readings (*« lectures »*) typically entail a specification of applied 'knapping techniques' and 'technical gestures' (Pelegrin 2000; cf. Bon 2009: 143). These, in turn, are interpreted holistically as a reflection of hominin cognition, psycho-motoric aptitude, and socio-technical choice (cf. Perlès 1991a).

'Knapping techniques' include interpretive categories such as soft and hard hammer percussion, *« pierre tendre »* (soft stone percussion) as well as direct, indirect, and tangential modes of detachment (Pelegrin 2000, 2005, 2011; cf. Soriano et al. 2007). These techniques are thought to imply particular ways of instrumentalising the body and of coordinating mind, hand, and torso – they imply *percussive movement* that necessarily refers to an embodied knapper (cf. Bril 1984). This, in total, constitutes the (historical) *knapping context* – a context that is identified as the transcendental condition for observing particular configurations of artefacts and stigmas of knapping. In the end, 'knapping techniques' are thus interpreted through the lens of Mauss' *Les techniques du corps* (1935) and are

[517] This 'cognitivist' category is of course rejected by those who embrace 'materialism' as the guiding philosophy of science and it is thus no surprise that 'mental refitting' has become a prominent target of critique (e.g., Tostevin 2000: 67; Chazan 1997: 728) – both from the perspective of 'mechanism' and 'formism.' Some of the prominent friction points in debating Levallois technology (Bar-Yosef and Van Peer 2009) can in fact be reconstructed along similar lines.
[518] This ushers in an anti-reductionist plea against artefacts as such. Describing lithic artefacts by their traits rather than in their globality can then simply be viewed as a reductionist manoeuvre; even individual artefacts tend thus to be interpreted 'synthetically' – a basal difference to 'analytic' conceptions of artefacts that cannot be overemphasised.
[519] These types of refits are sometimes referred to as 'technological refits.'
[520] 'Contextualism' thus actively supports the positive mobilisation of general background knowledge, epistemic experience, and a 'prejudice structure of knowledge' [*Vorurteilsstruktur des Wissens*] – epistemic qualities that are typically cultivated within hermeneutic and generally 'unlocked'/'open-ended' frames of reasoning.
[521] Note that for Tixier the difficult-to-solve problem of integrating insights from refits into quantitative lithic studies provided a strong incentive to re-orient technological research into the realm of qualitative inquiry (see e.g., Tixier in Tixier 1980: 14).

understood to echo speci-fic contexts of socialisation and learning – particular ways of using humanity's 'first instrument': the *body* (*idem*).[522]

'Technical gestures' are more complex entities and they refer to more general aspects of technology-body interlinkage(s) (Leroi-Gourhan 1968; Balfet 1991);[523] they are often used as a vehicle to reveal how bodily aspects of hominin technicity relate to volumetric aspects of core exploitation. Knapping is generally seen as a process through which technologies and hominin bodies become enchained and resonate with one another.[524] A technical gesture is nothing less than a specific mode of handling a particular volumetric structure (e.g., a 'core' or a 'biface') – giving voice to the idea of situated human-matter inter-action(s) (e.g., Pigeot 1987; Ploux 1988; Bodu 1994: 87f.).[525]

An obvious example of a particular mode of volume management is the involvement of events of re-orientating a core during lithic reduction – in which the volumetric matrix is turned and a new sequence of removals effectuated. Another example is the study of directionalities and angulations of knapping and their effects in relation to reconstructed volumetric structures (cf. Koehler 2011: Fig. 11).[526] This 'gestural' dimension of lithic technology is seen as central to any form of hominin technicity because it forms an irreducible part of the 'technical milieu.'

The study of 'rhythms of knapping' and 'progressions of knapping' represents another coordinate of mapping hominin-technology 'inter-action.'[527] Building on the early work of Pigeot (1983, 1987: 24) among others, this type of inquiry revolves around interpretive concepts such as *« débitage frontal »* (frontal débitage), *« débitage tournant »* (rotational débitage), *« débitage semi-tournant »* (semi-rotational débitage) and/or *« débitage demi-tournant »* (half-rotational débitage) – concepts which are designed to describe the distinct articulation of embodied knappers and the material and non-material correlates of their core extraction technologies (cf. Ploux 1988: Fig. 25, 26; Bodu 1994; Valentin 1995: Annexes [17-19]; Bon 2002: 40; **Fig. 32**).[528]

That this type of lithic research is still very much alive becomes clear if one invokes the recent study *Initialisation and progression of the core reduction* by Valentin and colleagues (2014), where

---

[522] This concept resonates with the ambition to portray prehistoric humans in their *l'homme totale* nature (technicity, cognition, and sociality are *imbricated* into each other) and to depict human technicity as a *« fait social total »* (cf. Marchand 1999a; Pigeot 2004: 255; Valentin 2008: 58-61) – both Maussian tropes.

[523] This is the reason why French researchers have pondered already early on drawing from the science of *« Ergonomie »* to elucidate handling modalities of lithic tools (cf. e.g., Perlès 1974: 818).

[524] The central point is that 'technology' is conceptualised *inclusively*, i.e. in very broad terms (see e.g., Balfet 1975; Sigaut 1994). Generally speaking, technology therefore includes corporeal practices and the instrumentation of the hominin body itself. This essentially mirrors Marcel Mauss' (1935) well-known notion of the body as humanity's 'first instrument.' The idea is that *bodily techniques*, as long as they display efficacity (material consequentiality), are as 'technical' as any other technique (cf. Sigaut 2007, 2012: 64f.). The implication is that technology can only be studied comprehensively if sensomotoric aspects of technicity are taken into consideration; an implication that has led to classifications and inventories of technical gestures (Leroi-Gourhan 1943) as well as the detailed investigation of motor actions of the human hand (e.g., Sigaut 2012: 37-56). The French notion of *« technologie »*, literally the 'science of techniques,' still carries this connotation (in contrast to the English term *technology* whose ordinary meaning is largely restricted to artificial productions). In France, there is an entire branch of socio-ethnological research dedicated to this topic. André-Georges Haudricourt (1946, 1964, 1987) and his 'gestural anthropology' are probably the most important manifestations of this particular approach to human technology (cf. Bert 2010; Sigaut 1978, 2012). Yet, what is perhaps most critical about this angle of research is that the concept of adaptation – at least compared to Anglophone interpretations – is *inversed*: rather than to view tools as an adaptation to the external environment, tools are instead regarded as *adaptations to human gestures* (« L'outil est adapté au geste et non inversement »; cit. Haudricourt 1987: 158); adaptation is thus internally directed, a factor that appears to undermine evolutionary 'adaptationism.' The associated pattern of thought ultimately gives way to definitions of tool-use and tool-functionality in terms of gestural factors – a predisposition explicitly reflected in François Sigaut's (2012: 92f.) distinction between 'true tools' (*outils vrai*/*outils nécessaires*) and 'auxiliary tools' (*outils auxiliaires*/*outils prothèses*): while manual gestures either assist or enhance the mode of action of the latter tool category, the mode of action of the former category remains *original* – i.e. no manual gesture would be able to perform a similar action of its own accord. There are thus several reasons why the emergence of 'true tools' is likely to mark a key threshold in technological evolution.

[525] 'Bodily techniques' are not necessary consciously executed and 'knapping techniques,' insofar as they can be viewed as 'bodily techniques,' must therefore be interpreted as a part of the socialised *habitus* (*sensu* Bourdieu 1972) of ancient hominins; that French lithic experts often employ the term 'algorithm' to describe embodied patterns of knapping (e.g., Forestier 1993; Soriano 2000: 285-287) underscores this largely 'unconscious' and 'pre-programmed' status of 'knapping techniques.'

[526] This typically requires that volumetric conceptions are reconstructed by finding an efficacious spatiotemporal 'place' for each artefact in an assemblage – a place that illuminates both the 'quality' and 'texture' of the technical context. In a second step, thereby reconstructed volumetric structures of lithic technology are related to particular methods by which each structure is exploited and maintained.

[527] This testifies to an inclusive concept of technology that involves 'more' than just material artefacts. The analysis of 'gestures' and 'techniques' as cornerstones of technological practice including their relationships to aspects of body instrumentalisation is firmly rooted in French 'gestural anthropology' in the wake of Georges-André Haudricourt and the 'Early' Leroi-Gourhan. For Leroi-Gourhan (1993 [1964/65]: 283, 309f.), the key concept was the evolutionary liberation of the hominin hand which establishes a certain 'freedom' to manipulate raw material volumes in a multitude of different ways.

[528] See also Marchand (1999b: 216, 2014: Figure 37), Bordes and Tixier (2002: 183), or Roussel (2013) for additional examples.

the authors devise a set of new interpretive concepts to shed light on core reduction habits reflected in 'symmetric' or 'dissymmetric' trajectories of core removal (**Fig. 33**). The widely cited work of Le Brun-Ricalens (2005) on the status of carinated endscraper technology in the Early Aurignacian represents a cognate attempt to disentangle aspects of rhythmicity and spatiotemporal patterns of lithic reduction (**Fig. 34**).

I cannot go into much detail here, but this approach provides ample opportunities to re-think variability at the interface between individuals and social groups – and hence to re-examine contextual aspects of lithic knapping such as 'skill,' *« savoir-faire »* (know-how), and 'social learning' (cf. e.g., Ploux 1988: Fig. 25, 26; Ploux and Karlin 2014; Leroyer 2016; Perlès 2016: 227; see Chapter 3). What remains important, however, is that these aspects are analysed by an exposition of various types of intra-technology *relations* and are hence explored from 'within,' without necessarily invoking much *a priori* or 'analogical' reasoning. It comes as no surprise that such inquiry into hominin technicity, including the 'gestural' dimensions of handling dissimilar lithic technologies, tends to inaugurate *technology-specific* insights – a classic fingerprint of contextualism and its preoccupation with *historical singularity*.[529] This general mode of reasoning groups under the umbrella of *« Palethnologie »* and seeks to 'rehumanise' the past through the study of ancient 'modes of life' (*« modes de vie »*) (e.g., Leroi-Gourhan 1971; 1983b) and their linkage with particular 'modes of doing' (*« manières de faire »*) (e.g., Pelegrin 1995: 35f.; Pigeot 2004: 178, 255)[530] – research that typically puts technical details centre stage and reflects an ongoing concern with 'novelty' and 'change' as structural categories.

We can thus conclude that *chaîne opératoire* analysis in its various manifestations – i.e. 'technological reading', 'mental refitting,' and the examination of *schémas diacritique* – attests to a deeply contextualistic logic of inquiry. Lithic assemblages are considered as 'situated' wholes; they have to be examined in terms of 'quality' and 'texture,' both in their synchronic integratedness ('spread,' 'fusion') and their infrastructural variability ('strands,' 'references'). In the process, 'qualitative relationships' are identified as the key loci of technological information (Perlés 2016: 223);[531] technical systems, therefore, tend to be studied with regards to their historical specificities. The resulting lithic knowledge claims are corroborated by their *workability* – that is, the overall consistency and 'barrier-freeness' of the totality of invoked arguments, assertions, and observations. This leads to an ongoing and generally open-ended exploration of contextual factors to characterise technological practice and knowledge, but the primary context of interpretation rarely exceeds the limits of the 'technical milieu' (cf. Pelegrin 2004).[532]

5.1.2 *Renard and Ducasse's structural techno-economics*

Renard and Ducasse's *De la rupture typologique à la fracture socio-économique* (2015) provides a second example of contextualistic reasoning in French lithic analysis. The paper proposes a synoptic re-interpretation of the Solutrean-Badegoulian transition in South-Western France. It draws on important doctoral research on the techno-economic organisation of the Solutrean (Renard 2010) and the Badegoulian (Ducasse 2010, 2012); the paper also integrates newer insights into non-lithic domains of material culture, most notably organic technology (e.g., Pétillon and Ducasse 2012; Baumann 2014). In general, the paper's approach marks a comparative shift in technological research and signi-

[529] This aligns with the structural category of 'novelty' (Pepper 1942: 235f.) and has also been described as a key interpretive category in French lithic analysis by Catherine Perlès (2016: 232).
[530] According to Jacques Pelegrin (1995: 35f.), specific *« manières de faire »* ('ways of doing') are coextensively interlaced with particular *« manières de voir »* ('ways of seeing') (cf. Pigeot 2004; Audouze and Valentin 2010: 35), again suggesting that distinct technical practices go hand in hand with characteristic cognitive operations. Following this trail of thought, one may conclude that particular ways of working stone reflect aspects of how ancient people have seen their world – stone working hence imbricates tropes of past cosmologies.
[531] Some of these 'qualitative' relationships – e.g., 'logical' and 'complementary' links – cannot, in principle, be 'quantified.'
[532] It cannot be overemphasised that the idea of the 'technical milieu' already demarcates a 'contextualistic' category; it defines the totality of means, objects, resources, agents, ideas, body techniques, etc. which are readily available in a given society-level context of technicity. It follows that, in order to understand a material correlate of a specific 'technical milieu,' it is required to scrutinise as many of the intra-milieu relationships that define the place of the material object in the milieu as possible. One may note that the idea of the 'technical milieu' already makes its appearance in the *œuvre* of the 'Early' Leroi-Gourhan (1943/1945), although he speaks of the 'internal milieu.'

fies the emerging potential of lithic scholars to bring to bear their 'localised' expertise in new and innovative ways.[533]

The main thesis, supported by an ongoing revision of dated evidence, is that the Solutrean-Badegoulian transition in South-Western France was associated with a radical re-organisation of societies on almost all functional and ideational levels. Accordingly, new taphonomically reliable archaeo-stratigraphic and radiometric data are summoned to support a rather swift and saltatory scenario of Solutrean-Badegoulian succession between 24 and 21 kya (*ibid.*: 196-198);[534] this sudden turnover is thought to be reflected in the evolution of the associated lithic technologies as well (*ibid.* 201). The authors argue that careful comparison of the two technical systems reveals two strictly opposing techno-economic conceptions, implying a true Badegoulian 'revolution' and thus a 'palaeo-historical' shift of considerable anthropological significance.[535]

De la rupture showcases a preoccupation with two of the key structural categories of contextualism – 'novelty' and 'change' (cf. Pepper 1942: 235) – and epitomises the contextualistic core intuition that no context is identical to any other context, re-casting contextual wholes as critical difference-making factors. The resulting mode of 'world-making' is particularistic rather than nomothetic; facts are born out of changing 'situationalities,' and an ongoing re-organisation of contexts and their contents is seen as the historical *status quo* rather than the exception.[536] According to Renard and Ducasse (2015), this is precisely how we should make sense of the transformations that led from the developed Solutrean to the Badegoulian. As signalled by the title of their paper, the observable typological 'rupture' between the two complexes can be considered a consequence of a pervasive 'fracture' between two techno-economic systems. In this light, the Badegoulian appears as a true 'palaeo-historical' contingency not predictable from the Solutrean substrate: it systematically breaks with the latter's systemic logic and implies a fundamentally new 'way of living.'

The same contextualistic logic is employed to present the lithic evidence and to define the technological 'context' of its comparison; the aim is to expose the common threads that run through the Later Solutrean and the Badegoulian, necessitating the disciplined comparison of the technological 'mean signatures' of the two techno-cultural entities:

> "[...] we have opted for an "integrated" and qualitative presentation of the data by contrasting two complexes: the younger Solutrean on one hand (i.e., the *Solutreén à pointes à cran*) and the Badegoulian on the other (i.e., the *Badegoulien ancien* and *récent*).The proposed hypotheses are thus based on a synthetic view "averaging" each of these complexes, a undertaking necessary to putting them into perspective in the broadest possible sense" (Renard and Ducasse 2015: 195; my translation [for the original French quote, see **Appendix Q.12**])

This cognitive strategy is both 'synthetic' and contextualistic – it concentrates on the main features that hold techno-cultural wholes together in time and space ('spread' of 'quality') and thereby defines the contexts of comparison. The important point is that this approach precludes any form of direct confrontation of artefact features and traits because, to become comparable, these must first be translated into context-level characteristics. The comparison of entire technical contexts, typical for contextualism, can only be effective if one investigates resemblance in terms of the 'quality' of each context, reconstructed by a detailed exposition of its techno-economic infrastructure (its 'texture'). What are effectively compared this way are larger configurations of relations, rather than merely the composition of object-level properties.

The details of Renard and Ducasse's technological analysis are highly diagnostic and may serve here as an illustration. The first aspect of note is that the authors, in line with our expectations, base their interpretation almost exclusively on an evaluation of technological 'structures,' by which they mean qualitative wholes defined by second- and higher-order relationships. Such relationships specify the connection(s) between two or more groups of interrelated artefact nodes. They theorise how 'dis-

---

533 We can recognise this trend as an attempt to counterbalance the 'contextualistic' dilemma of being trapped in one's own context of research; the comparative manoeuvre acknowledges this condition but hopes to bring different contexts into new dialogue by confronting them in terms of both 'quality' and 'texture.' This, in turn, greatly motivates the drawing together of complementary lithic and non-lithic expertise.

534 This part of the argument is crucial since it aims to reject alternative explanations based on population movements and/or the gradual integration of Solutrean and Badegoulian signatures.

535 Their argumentation, therefore, implies a resolute critique on persisting notions of gradual 'transition' (processes e.g., baptised as *« désolutréanisation »* or *« magdalénisante »*).

536 See also Bon (2009: 243, 337) for a similar view.

order' and 'fusion' produce intelligible technical contexts and the place of individual objects, operations, and other technical processes in these contexts:

> "The status of each of these [lithic] productions is thus defined with regards to the entire lithic technical system in order to assess the techno-economic investment that is respectively conferred on them as well as their level of mutual dependence (integration or disjunction of objectives, economic "hierarchy"). Solutrean and Badegoulian lithic productions can hence be compared step by step and aspect by aspect in order to measure their degree of techno-economic affinity." (Renard and Ducasse 2015: 194; my translation [for the original French quote, see **Appendix Q.12**]).

A pivotal disparity in techno-economic structure between the Developed Solutrean and the Badegoulian is thought to become evident when the relationship between the production of 'domestic' elements of technology and elements that support 'hunting' activities is examined in detail (Renard and Ducasse 2015 : 201). This provides a typical example for 'infrastructural' reasoning since a context's 'quality,' its global structure, is elucidated by analysing the interplay of significant sub-structures, so that the resulting architecture of sub-structures may be mobilised to describe the context's 'texture':

> "[...] the techno-economic approach shows that between the Solutrean and the Badegoulian, it is the structuring of the technical system itself which seems to have undergone profound changes. The Badegoulian of the French South-West appears indeed as a moment of total overhaul where the techno-economic architecture of the system of production and the management of lithic equipment is completely reworked [...]. This reorganisation is reflected in particular by a new economic relationship between domestic tools and hunting weapons, a new balance of which we propose to explore the correlates in terms of the spatio-temporal organisation of activities." (*idem*; my translation [for the original French quote, see **Appendix Q.12**]).

The above quote further suggests that the authors tacitly galvanise a concept of 'functional equilibrium' to make sense of technological 'infrastructure;' they look for stable relationships between the two technical sub-systems ('domestic' vs. 'non-domestic') to draw techno-economic conclusions. To find context-internal equilibrium conditions between technical spheres dealing with 'domestic' tools and those dedicated to 'hunting' equipment is nothing less than an attempt to characterise the 'operation' (*fonctionnement*) (*sensu* Sigaut 1991) of a technical system by removing all 'blocking' strands and other epistemic obstacles that inhibit overall interpretive consistency. 'Internalist' equilibrium considerations can thus clear the view for the 'texture' of a technical context and help to work out the structural and functional division of labour that defines it.

The authors emphasise that different equilibrium solutions seem to specify the Developed Solutrean and the Badegoulian respectively; each context is depicted as an original integration of different types of lithic production and different systemic trade-offs can consequently be observed (Renard and Ducasse 2015: 198-203, Fig. 2). This type of reasoning expresses a proclivity toward portraying structural 'novelty' and spelling out its contextual corollaries; additionally, this approach again highlights the fact that 'infrastructural' differences in technological organisation are thought to reflect marked differences in the 'quality' of the techno-cultural contexts in question. In a manner characteristic of contextualism, it is thus the 'qualities' of contexts that are ultimately compared in order to gauge similarity and difference.[537]

The process by which the 'texture' of two or more technical systems is explored is equally informative and reflects a more general approach to Upper Palaeolithic technicity that is currently influential in the French scene. This approach rests on two complementary pillars. The first pillar is the distinction between a 'domestic' and a 'hunting-oriented' component of lithic technology (cf. Ducasse 2012: 153; Renard 2010), put forth by Bon (2005, 2009) and others (e.g., Geneste and Plisson 1986; Geneste 2010 [1991]: 437f.; Texier et al. 1998; Tartar et al. 2006; Teyssandier et al. 2010; Pelegrin 2011; Bachellerie et al. 2011; Anderson et al. 2015).[538] 'Domesticity' thereby refers to everyday activities tied to the needs of sustaining human settlement – i.e., scraping and cutting duties performed primarily at occupational sites – while the 'hunting' domain includes all activities focused on the extraction of

537 This is of course very different in 'mechanism' or 'formism' as we have seen, where discrete features of parts or selected ties between/relationships among these parts are mobilised to assess similarity and difference in lithic technology (see Chapter 4).
538 The purpose of this distinction is to theorise the differential contribution of parts that form sub-structures in a technical system to the overall 'function' (*fonction*) of the system; it is their differential interplay that is considered key to determining aspects of 'quality' and 'texture' of the technical whole and to investigating how the system generally works.

animal resources, in particular meat and fat, which require the killing of these animals – i.e., duties facilitated by specialised lithic implements that are parts of armature and weaponry systems. Although the involved spatial dynamics are certainly important, the focus remains economic; the goal is to separate lithic production modes and modification strategies that result in differentiated tool-kits ('domestic' vs. 'hunting-oriented') and thus reflect a diversification of economic needs. This amounts to nothing less than an inquiry into the economic 'status' and 'role' of different functional parts in a larger technical system.[539] The inclination is of course deeply *relational* – the resultant approach enables the investigation of how technical components of potentially dissimilar economic status relate to one another on the systemic level, e.g., whether or not the components are technologically 'integrated' or 'disintegrated.'

The second pillar is the proposal, popularised by Jacques Pelegrin (1995, 2000) and others (cf. e.g., Tsanova et al. 2011; Valentin 2011: 31; Langlais et al. 2012), that lithic technological evolution in the Upper Palaeolithic was driven largely by a need to prepare and maintain well-defined projectile technologies, tethered to new hunting tactics (cf. Pelegrin and O'Farrell 1998; O'Farrell 2004). The resultant research objective is to identify 'levels of hierarchisation' within and between blank production systems and to assess whether particular ways of organising lithic reduction respond to the 'needs' of particular mobility and hunting systems. The guiding idea is that lithic technicity in the Upper Palaeolithic was *anchored* in the production of more or less well-differentiated projectile blanks and that the emerging key problem is thus to also support other 'domestic' needs (e.g., Valentin 2011: 66; Bordes and Teyssandier 2011).[540] From a contextualistic perspective, this dilemma can be reformulated in terms of the structural categories 'quality' and 'texture:' the fact that technical systems foreground the manufacture of blank-types destined to become part of the hunting equipment pertains to the overall 'quality' (immanent total meaning) of the technical systems. The price of this technological 'quality' is the need of organising the system in such a way that the full spectrum of tasks can still be supported, and eventually impacts the 'texture' of the system (grammatical relations). The analysis of 'technical intentions,' that is, the techno-economic 'purposefulness' of a lithic system, then simply consists of the determination of the distinct liaison between 'quality' and 'texture' which leads to distinct patterns of systemic 'operation' (cf. Pelegrin 2011: 146).

Renard and Ducasse (2015: 194) integrate these two angles of inquiry to show that the fabrication of hunting equipment in the Developed Solutrean appears to have a radically different techno-economic status than in the Badegoulian (**Fig. 35**). In the Solutrean, armature and projectile point production are found to lie at the heart of the technical system and the entire system appears to be oriented towards the generation of suitable blanks to support this 'non-domestic' component of technicity (*ibid.*: 198). This privileged status of the hunting-related 'strand' of lithic technology is signalled by a number of interrelated organisational features which typify the techno-economic architecture of the Solutrean.

First, blank production is 'diversified' and furnishes a panoply of 'domestic' tool types – e.g., scrapers, burins, and borers – but these types are neither tied to a specific *chaîne opératoire* dedicated to produce them, nor are they manufactured on the blanks of 'primary intention' that are extracted from the dominant blade production system.[541] Instead, 'domestic' tools are primarily produced from

---

[539] The objective, again, is to determine the 'operation' (*fonctionnement*) of the system in light of the orchestration of its parts.
[540] The important point is that such a shift in the nature of the economic problem-situation is possible. Other 'qualities' of a technical system may face other kinds of economic issues – technologies may, for instance, be oriented towards 'domestic' production, therefore requiring the 'non-domestic' tool domain to be supported by 'infrastructural' means. The activities enabled or facilitated by a technical system and the technological problems it generates are therefore always a product of the dynamic interplay between the 'quality' and 'texture' of a technical context; they cannot be defined or known without knowledge of the technical context itself.
[541] Lithic products of 'primary intention' are not just 'intuited' but are *determined* in the course of careful 'synthetic' examination. The main point is that 'technical intentions' are not extracted from individual lithic artefacts and their characteristics, but can only be studied in the light of system-level properties. A technical system is 'purposeful' or 'directed' insofar as it has a 'function' (*fonction*) – typically referred to in the French literature as its 'finality' – and blanks of 'primary intention' are those blanks that serve or support the respective systemic 'function.' This also means that assessments of the sort implied by categories such as blanks of 'primary intention' depend entirely on the determination of the immanent 'quality' of a technical whole. The inferred structure of 'intentionality' therefore generally mirrors the 'texture' of the technical system in question; 'intentionality' can then be hierarchised by evaluating how systemic 'quality' authors a specific systemic 'function' and how the two articulate (or not) with the documented systemic 'infrastructure' ('texture'). All of this is perfectly 'contextualistic' since all of these categories can be defined only in mutual dependency and are amendable to constant modification and correction; it is ultimately the inter-relationality between them that enables conclusions about the 'purposefulness' of a technical whole and the status of various parts (e.g., lithic artefacts) within all of this. 'Purposefulness' defined in this sense is a genuinely 'contextualistic' category.

by-products and preparatory blanks that arise during blade production and its maintenance. The raw material base of these 'domestic' tools is rather heterogeneous and represents a mix of local and non-local materials of varying quality, larger endscrapers constituting perhaps the only exception to this configurational logic.

Secondly, the treatment of 'domestic' elements contrasts with the handling of large blades accounting for the blanks of 'primary intention.' These blanks are either transformed into *pointes à cran* or provide the raw material for different variants of 'laurel' leaf points. Secondary modification (retouch etc.) of these pieces attests to elevated levels of 'economic investment' (*ibid*.: 199); for instance, they regularly exhibit secondary surface shaping (*façonnage*) by means of flat pressure flaking – a treatment that is completely absent in the 'domestic' sphere of production. Although the raw material spectrum covered by these 'non-domestic' tools is also diverse, the diversity is primarily a function of high-quality raw materials, testifying to the 'mobility' of the objects and the 'planning' and technical 'anticipation' involved in their production. Some of the extra-large 'laurel' leaf points can even be interpreted as *couteau de chasse* (hunting knives) and hence emerge as a supplement to the primary 'hunting gear' in the form of projectile points (*ibid*.: 201).

Thirdly and certainly related to the previous point, many of the bifacially shaped objects seem to be 'over-designed.' They can be interpreted as signalling economic 'over-investment' and embodying a high level of 'technical competence' (*« savoir-faire »*), perhaps even reflecting the 'valorisation' of certain 'non-domestic' needs (*ibid*.: 203f.).[542] The resulting relative imbalance between 'domestic' and 'non-domestic' spheres of lithic production is interpreted in terms of a proper *hierarchy of techno-economic organisation* (*ibid*.: 203): 'domestic' and 'hunting-related' (*« cynégétique »*) needs are regarded as well-separated and infrastructurally differentiated. While the production of 'domestic' blanks appears to be 'embedded' and is thus not implicated in the overall 'quality' of the technical system, there is an over-accentuation and elaboration of technical means of assembling projectile elements and other specialised tools that support hunting trips.

This general architecture of the Solutrean contrasts markedly with the lithic evidence from the Badegoulian. Renard and Ducasse (2015: 201) argue that domestic and *cynégétique* needs in the Badegoulian are deeply entangled with one another and seem to be fully integrated. The respective *chaînes opératoires* are thought to evince an 'imbrication' (overlap) of 'domestic' and 'nondomestic' needs. This techno-logical structure is captured by the notion of 'ramification.'[543]

In contrast to technological organisation in the Solutrean, Badegoulian technical systems are based almost exclusively on the production of flakes (Renard and Ducasse 2015: 201). These flakes vary in shape and size, are often slim in character, and are used as blanks for tools but also as volumetric matrices for the production of bladelets and micro-bladelets. In addition, the raw material base for the manufactured tools is largely of local origin. The articulation of all of these factors is interpreted as *non-hierarchical strategy* of volumetric exploitation, capable of quick-and-easy adjustment to local circumstances (*idem*). Badegoulian lithic technology is consequently seen as inherently 'transformative' and relatively flexible in its ability to satisfy different production needs. It follows that the distinction between objects of 'primary intention' and objects of 'secondary' or even 'tertiary intention' makes little sense in such a technological context – a finding that speaks to the basic difference in 'texture' between Badegoulian and Solutrean techno-economic contexts.[544]

In total, Badegoulian technological organisation is viewed as expounding to a *plurality* of co-existing 'technical intentions,' which are enshrined in a single sequence of continuous but structured lithic reduction (Renard and Ducasse 2015: 202). Moreover, the centrality of flake matrices in the techno-logic of the Badegoulian is thought to reveal the *polyvalency* of this blank-type in this particular context as well as the fundamental 'pliability' of the techno-economic systems it hosts.[545] *De la rupture* therefore proposes to understand the differences between Solutrean and Badegoulian techno-economic organisation in South-Western France as the symptom of an abrupt transition from differen-

---

[542] See also Geneste and Plisson (1986), Renard and Geneste (2006), and Pelegrin (2007, 2013).

[543] The structural analogy for this 'arboreal' or 'dendritic' organisation of lithic reduction is derived from previous work on variants of the French Mousterian (Geneste 1991; Bourguignon et al. 2004).

[544] However, one might nevertheless speak of a 'nested' structure of blanks since flakes that are used to produce micro-flakes or bladelets are often blanks themselves (core-on-flake system) – this is of course precisely the significance of a 'ramified' techno-logical structure.

[545] Renard and Ducasse (2015: 202) speak explicitly of « *matrices polyvalentes* ».

tiated and highly specialised production systems with a clear focus on projectile weaponry and hunting equipment to more integrated modes of production in which 'domestic' and 'nondomestic' needs were expediently satisfied. With Pepper we can conclude that the difference in techno-economic 'quality' between the Developed Solutrean and the Badegoulain pertains to a clear-cut disparity in the 'texture' of the two contexts, which is expressed in the differential relationship between 'domestic' and 'non-domestic' domains of lithic organisation.[546]

In typical contextualistic fashion, Renard and Ducasse (2015: 203-206) further suggest that these disparities in techno-economic organisation can be brought into dialogue with structural differences between some of the non-lithic domains which are tied to the respective lithic systems. They highlight mobility systems and their associated organic technologies (*idem*). We can thus characterise their approach as *hyper-relational* – intra-technological relations are used to describe the 'structure,' 'operation,' and 'function' of a technical whole, only to analyse the interconnections between the whole and other wholes of its wider 'super-structural' surrounding; this amounts to nothing less than the introduction of a higher level of analysis, on which wholes again become parts and are examined in their systemic interplay.[547] It also shows that we are dealing with a 'soft' ecology approach, where 'interpenetration' is the regulative idea and everything potentially shapes (and is shaped by) everything else. The advocated contextualism is 'refined:' categorically distinct domains of reality (lithic technology, mobility, organic technology, etc.) are understood to be massively intertwined,[548] and a 'dynamic' interpretive holism takes centre stage.[549]

This holism enables the exposition of 'palaeo-historical' articulations of *l'homme total* ('the complete man') (see **Appendix II.3**);[550] human realities can be reconstructed in their totality since even the study of a single context of reality (e.g., technical) allows conclusions about other contexts (e.g., mobility, worldview, cognition, etc.) to be drawn. The reason is unmaskingly contextualistic: everything is interconnected with everything else and thus points to everything else.[551] *L'homme total*, however, is always 'situated' since each broader historical context ('super-context') is substantially unique, reflecting contextualism's commitment to 'novelty' and 'change.' The consequence is that, if techno-cultural entities such as the Solutrean or Badegoulian are re-cast as significant contexts of interpretation, they tend to yield divergent descriptions of *l'homme total*. The *homme total* of the Solutrean thereby differs from *l'homme total* of the Badegoulian.[552] This is probably precisely what is referred to when Renard and Ducasse (2015: 194) stress the 'anthropological signification' of the systemic changes they observe at the Solutrean-Badegoulian boundary. The two contexts ultimately showcase different instances of being human.[553]

The authors enunciate that the Developed Solutrean and the Badegoulian were characterised by two distinct ways of organising activities in space and time, which they identify with "two quasi

---

[546] Again, what is identified as 'domestic' and 'hunting-related' varies between the two structural wholes and is thus context-dependent. In sum, this approach therefore provides a prototypical example for the 'contextualistic' tendency to delineate and compare context-specific features of the same kind.

[547] We can thus speak of reality as a highly structured and granular entity. There are several levels of analysing 'texture' and 'quality,' so that one can examine 'texture'-'super-texture' relations and so forth. From the perspective of 'contextualism,' the purpose of such continuous exploration of lower and higher levels of analysis and their inter-linkage is to determine to 'spread' of the ultimate explanatory contexts.

[548] This is perhaps where Pepper's structural category of 'fusion' comes into play. According to Pepper (1942: 243), the 'quality' of a context always exhibits some degree of fusion of the details of its 'texture' – an aspect that secures the unity of 'quality' and 'texture.' Thus, 'fusion' motivates scholars to conceptualise the world as an *entangled whole*.

[549] Interpretation is exhaustively 'synthetic;' the idea is simply that every aspect of reality is potentially implicated in any other aspect of reality. It follows that technicity, sociality, cognition, and so forth are systematically embedded in each other; each of them consequently has implications for all others, or, in other words, analysis of any of them may deliver conclusions about all others. Needless to say, conclusions become much more robust as more aspects, domains, and/or categories of reality are taken into account. To a certain degree, contexts that by definition enshrine only parts of reality can then be viewed as 'microcosms' of the whole of reality. French-type *chaîne opératoire* analysis aims to do precisely this: to provide an account of technical systems as 'microcosms' of society, cognition, practice, and body instrumentalisation, to name but a few (see e.g., Bon 2009: 143, 213 for an explication).

[550] For a detailed discussion of Mauss' *l'homme total* conception, see e.g., Schlanger (2012).

[551] Cf. **Appendix II.3: Fig. II.1** for the interplay between the 'contextualistic' constitution of worldly affairs and the regulative idea of the *l'homme total*: the vision of the *l'homme total* can be brought into fruitful contact with what Hans-Peter Hahn (2013: 34f.) has identified as the 'pound-cake model' (*Rührkuchenmodell*) of sociocultural realities.

[552] We can interpret this as a reminder of *deep time alterity*, in the sense that even humans that biophysiologically resemble modern humans are likely to have been very different from us in how they lived, thought, and behaved. Placing emphasis on facets of 'alterity' is a regular feature of 'contextualistic' reasoning (see Chapter 2).

[553] In Éric Boëda's 'organicism,' this inclination gives way to what I call a 'radical anthropology of alternative humanities' (see second part of this Chapter).

oppositional solutions of anticipating needs" (Renard and Ducasse 2015: 203, my translation). The Solutrean techno-economic profile, with its high potential for functional differentiation, is shown to correspond to a settlement system that is characterised by a 'complementarity' of distinct techno-economic site profiles in geographic space (*idem*). Techno-economic differentiation in the Developed Solutrean is therefore thought to be reflected in a diversity of site functions. The 'texture' of lithic technology, in other words, is shown to be mirrored in the 'texture' of the mobility system. By contrast, the techno-economic structure of the Badegoulian appears to correspond to a settlement system comprising a multitude of sites with relatively 'stable' techno-economic profiles, but hosting a rather diverse set of activities (*ibid.*: 203f.).

For Renard and Ducasse (2015: 203), this structural difference provides further evidence that hunting activities played an outstanding role in the Solutrean, potentially betraying a strong 'segmentation' of the social realm and the extraordinary socio-political status of some individuals (cf. Renard and Geneste 2006; Pelegrin 2007, 2013). The situation in the Badegoulian appears to be very different. Badegoulian technology comes into view as a technology *« tout-terrain »* ('all-terrain') centred on 'adaptation' and 'travelling.'[554] This is taken to suggest that Badegoulian society was probably more 'collective' and mobility likely took 'cyclical' forms (Renard and Ducasse 2015: 203).[555] The inherent 'technical suppleness' (*« souplesse technique »*) of the Badegoulian is regarded as having enabled the relative stability of lithic toolkits across a vast geographic extent, which explains the spatiotemporal homogeneity of this techno-cultural complex at large (*ibid.*: 203, 205). This homogeneity can be contrasted with the relative spatiotemporal heterogeneity of the Developed Solutrean, which is known for its well-delineated regional groupings that are often centred on distinct styles of projectile heads (cf. Smith 1966). Thus, there seems to have been a proper 'cultural geography' in the Solutrean (*ibid.*: 205; cf. Ducasse and Renard 2012),[556] whereas a similar structure-giving geographic moment is missing in the Badegoulian.[557]

The cognitive strategy is to relate specific *« manières de faire »* ('modes of doing'), identified in the realm of lithic technology, to particular *« manières d'occupation »* ('modes of occupation') reflected in settlement patterns, in order to evoke associated *« manières de penser »* ('modes of thinking').[558] Different contexts of past reality are compared in terms of their configurations to demonstrate that they share a similar structure; this is then taken as evidence for a stable 'super-structure' regulating the observed structures.[559] The strategy, in a manner characteristic of contextualism, is also decisively 'dispersive' since the search for the unifying super-structure that provides 'quality' to its elements is guided by the *proliferation* of fact (addition of contexts). Moreover, knowledge is corroborated by a pragmatic principle of verification: one context is taken as a training ground to develop a consistent and beneficial interpretation of its 'texture' and 'quality'; the structural features of the latter are then retraced in added contexts on a similar level of analysis. If the structural qualities of the training context turn out to be helpful in elucidating the added contexts and their links to the original training

[554] An obvious metaphor to circumscribe Badegoulian lithic technology, although not explicitly mobilised, is that of the *mountain bike* or *amphibian vehicle*.

[555] The authors explicitly refrain from the use of theoretical models in the vein of Binford and others to characterise the kind of mobility they are most likely facing (Renard and Ducasse 2015: 204). This seems counterintuitive at first glance (Badegoulian mobility seems to conform to a 'residential,' Solutrean mobility to a 'logistical' one). However, the underlying contention seems to be that *deep time alterity* cannot be taken lightly. The argument is that mobility is not explained or illuminated by simple categorisation, but by taking seriously its idiosyncrasies and relating it to other characteristics of the same reality in order to flesh them out. This comes close to saying that there can be no *a priori* categories within which one can meaningfully place mobility systems of the deep past – a prototypical argument of 'contextualism.'

[556] This detail is important since the technological centrality of hunting-gear production mirroring that of projectiles and other 'hunting-related' weaponry is directly reflected in the fact that these products became a factor in catalysing regional fragmentation during the Solutrean. In other words, the fact that these pieces and not others played a role in organising proper 'territories' attests to their more-than-functional significance.

[557] For the specific corpus of theoretical literature on 'cultural geography' typically referred to by French scholars, see e.g., Bonnemaison (2000), Claval (2001, 2003), Chivallon (2003), Allemand (2004), Rasse 2010, and Di Méo (2008); for an explicit treatment of the topic in French Palaeolithic archaeology, see Bon (2009: Chapitre III) and Chevrier (2012: Chapitre III.3).

[558] The authors deliberately evoke these notions in some of their section headings: e.g., *Deux manières d'occuper le territoire ?* ('Two manners of occupying the territory?') (*ibid.*: 203) and *Pour deux manières de penser le territoire ?* ('For two manners of thinking the territory?') (*ibid.*: 205).

[559] The way in which this 'super-structure' is conceptualised of course varies among French practitioners. An example is François Bon who, in *Préhistoire. La fabrique de l'homme* (2009: 324), explicitly declares: "[…] [b]ut the important thing is to recognise the articulation of these various domains – economic, technical, religious – around the ideological structure that renders a human group a true human society. And this without starting from the assumption that the most accessible domains, like those pertaining to the techno-economic identity of a given population, act in the form of a more powerful determinant than other components of the same society." (my translation [for the original French quote, see **Appendix Q.5**])

context, the interpretation is found to be 'workable.' This confirmative strategy is typical of developed forms of contextualism.[560]

As a last manoeuvre, Renard and Ducasse (2015: 204) argue that the distinct logic of 'domestic'-'nondomestic' interaction in the Developed Solutrean and in the Badegoulian is supported by the nature of economic investment in organic tools in both periods (**Fig. 36**). Based on the work of Chauvière, Pétillon, and Baumann, they contend that Solutrean organic technology exhibits a strong investment in organic points and other 'hunting-related' objects – the only notable exception perhaps being *compresseurs* (*idem*).[561] This pattern obviously *reproduces* the general hierarchy between 'domestic' and 'non-domestic' spheres of lithic production. In the Badegoulian, to the contrary, the organic technological domain attests to an economic 'equilibrium' between 'domestic' and 'hunting' armature (*idem*). The authors take these findings as evidence of the validity and generality of the organisational relationships they have isolated. This part of the argument simply confirms what has been said earlier, namely that knowledge corroboration is pragmatic and the mode of inquiry holistic and 'hyper-relational.'

To strengthen this general systemic reconstruction, Ducasse and colleagues (2016) have recently integrated evidence on personal ornaments and other 'artistic' domains of material culture from both the Developed Solutrean and the Badegoulian; this evidence is thought to reproduce and thus to confirm the division. This again brings to light the 'dispersive' nature of inquiry and corroboration. It is once more the *proliferation* of fact, through the enumeration of even more contextual evidence which is regarded as helping secure scientific 'approvability.' The approach is 'dispersive' because its strength is to include a broad latitude of available data without presuming from the start that some data are more important than others; the same methodological symmetry holds for the domains of reality which have been included in the analysis – none are regarded as privileged, but instead viewed to point equally to the same 'super-structure' or 'macro-context.' The combined evidence for Pepper's contextualism is thus overwhelming; its structural categories greatly clarify what the authors have done and why they have done it.

5.1.3 *« Approche techno-economique » and group mobility*

Following the discussion in the previous section, it is instructive to take stock of the so-called French 'techno-economic approach' more generally (e.g., Perlès 1980, 1991b; Pigeot 1983; Geneste 1985, 1991 [2010]: 429-431; Jaubert 1993; Cretin 1996; Geneste and Jaubert 1999; Thiébaut 2006: Chapitre II; Renard 2010). This approach is already contextualistic in terms of its basic premises and orientations: it is primarily interested in the interplay between – that is, the 'co-fashioning' of – technology and economy. A key assumption is that *technological* and *economic rationalities* are largely co-extensive.[562] Techno-economic inquiry is typically concerned with the *economic implications* of vary-

[560] This 'theory of cognitive criticism' is probably a combination of what Pepper (1942: 272-278) identifies as the 'contextualistic' principle of a *verified hypothesis* and *qualitative confirmation* (see Chapter 2). The insights from the original training context are used to 'inductively' develop a number of hypotheses which are then explored in the added contexts ('direct verification'); the 'qualitative confirmation' theory, on the other hand, simply states that all elements, 'strands,' and/or 'references' take up the qualities of their context, which means that a multiplication of recurring structures can be regarded as indicative for the fact that these somehow take up the 'quality' of their overarching context ('super-context'). One therefore confirms what one asserts if and only if one retraces particular structural features of the whole in its parts, whereby wholes and parts are dynamically defined.

[561] *Compresseurs* are bone objects with often marginal traces of utilisation that are difficult to decipher (Patou-Mathis et al. 2002). It is interesting, however, that a possible role of these items in applying pressure for lithic retouch has regularly been invoked. Needless to say, a 'synergetic' relationship with practices of shaping foliates in the Solutrean would further strengthen the argument presented by Renard and Ducasse. It would directly tie these pieces to 'hunting-related' domains of lithic technicity and further detach them from strictly 'domestic' spheres of production and use.

[562] It is noteworthy that the mobilisation of essentially hybrid terms such as 'techno-economic' or 'techno-economy' to describe the project of lithic economic inquiry is largely restricted to the Francophone world. In Anglophone research, by contrast, scholars typically speak of 'lithic economy,' 'economy,' and/or 'economics.' While technology and economy fuse terminologically into each other in the first case, they are typically kept separate in the latter. This observation alone signals that largely distinct conceptions about the nature and status of economy are in place. It also indicates that in the Anglophone world economic aspects of lithic technology are really approached from the perspective of *economics*, a specialised academic field with specialised theoretical and methodological resources but mainly concerned with the present day. In addition, and I will return to this point below, economy in Anglophone research is often seen as a 'glue' that aids the understanding of how technology interfaces with its natural exterior (see Chapter 4). In France, the 'fusion' of technical and economic aspects is thought to illuminate how technology is stitched to its sociocultural substrate and how techno-economy is therefore always socially embedded.

ing technological make-ups.[563] Lithic economy, a term that is in fact rarely used, is therefore studied from the perspective of technical wholes rather than from the viewpoint of generalisable economic principles or laws. The idea, again, is that both domains of reality – technology and economy – 'interpenetrate' each other and therefore *inscribe themselves* onto each other's structure (cf. Perlès 1991a: 9). The technical 'interface' is thought to resonate both with its economic neighbour and with the societal whole and thereby picks up key characteristics of both. This inherently 'contextualistic' trope furnishes the central research mandate for French techno-economic studies.

Techno-economic inquiry in the French tradition effectively begins with Marie-Louise Inizan's *Nouvelle étude d'industries lithiques du Capsien* (1976), in which the author coined the interpretive concept of *« économie de débitage »* ('blank production economy') (see also Inizan 1980) – a concept that is still widely used today. Lithic approaches that draw on this concept set out to investigate the economic dimension of varying blank production systems (*débitage*). The guiding motivation, consistent with what has already been said, is to theorise and examine the precise economic implications and effects of organising lithic reduction in a number of different ways. Again, the 'structure' (*structure*) and 'operation' (*fonctionnement*) of a given technical system – i.e., the 'infrastructural' features of the targeted lithic technology – are viewed as informative of the system's economic status and purpose; in other words, the 'texture' of technology is used to infer a special axis of its 'function' (*fonction*): its *« fonction économique »* ('economic function'). The interaction between the two is regarded as providing critical insights into the 'economic quality' of various technical systems.

A central line of techno-economic investigation is to evaluate the differential capacity of lithic technological systems to support blank 'normalisation' or 'standardisation,' the 'diversification' of blanks, tools, and/or raw materials, and whether and in what way they require 'technical investment,' 'anticipation' and/or collective 'planning' (*planification*)[564]. While a lot of research has traditionally been dedicated to better understanding the interaction of knapping concepts and tactics with different raw material qualities and formats (e.g., Pigeot 1987; Meignen 1988; Geneste 1989; Perlès 1991b; Cretin 1996, 2000),[565] recent approaches have increasingly paid attention to 'inter-technological' trade-offs (e.g., Soriano 2000; Soressi 2002; Faivre 2008; Brenet and Folgado 2009; Brenet et al. 2014); that is, how different economic needs can be satisfied by employing a number of distinct technical solutions that complement and/or support each other economically.[566] The contextualistic inclination of this type of research is evident. Various technical 'micro-contexts' in the form of particular technological systems (e.g., various Levallois concepts, Discoid, Quina, and/or varying bifacial technologies) are related in such a way that their larger economic 'macro-context' becomes apparent; thus, the configu-

[563] Methodologically, this direction of inference and argumentation is explicitly laid out in 'Fig. 1' of Renard and Ducasse (2015).

[564] The notion of *planification*, which is regularly invoked when French scholars address the problem of economy (e.g., Bon 2009: 252; Langlais 2010: 301), carries a strong social connotation; it again signals that the 'techno-economic' approach is based on the conception that technology, sociality, and economy are mutually *embedded* into each other. This conception brings French techno-economic inquiry close to 'substantivist' views in economic anthropology (e.g., Polanyi 2001 [1944]; Dalton 1961, 1969), where economy is theorised as an expression or derivate of sociocultural organisation (and not the other way around!). Although the term *planification* is still best translated as 'planning,' its meaning is historically informed and refers to a top-down form of *collective planning*. The term was used originally to designate types of economic planning in which regulation, control, and coordination by higher-order (i.e. state) institutions played a cardinal role (cf. Quinet 1990). Economic planning understood in this way transcends the level of individual action and potentially even precedes the awareness of individual actors; strictly speaking, *planification* signifies a deeply sedimented form of patterned economic organisation which is negotiated on the highest society-level. It is therefore inconsistent with 'methodological individualism' and 'atomistic' reasoning (see Block and Somers 1984 for some of the reasons).

[565] The early work of Nicole Pigeot (1987) is an example of inquiry focussing on the economic interplay between raw material quality, knapping skill (technological variability), tool functionality, and the use of an excavated habitation space. Her results of the combined analysis of these various factors indicate that in the Magdalenian of Etiolles U5 high-skilled production of high-quality blades occurred around the central hearth area, whereas other flint-knapping areas probably result from the activities of less-skilled knappers who primarily produced expedient products and tools for immediate domestic consumption. Therefore, different economic needs may be satisfied by different people and different technical competences can be used to examine intra-group divisions of labour.

[566] A good example for this type of inquiry is the doctoral research of Sylvain Soriano (2000) introduced in Chapters 1 and 3. The central point of this study was to identify the changing logic of interaction between flake-production systems (*débitage*) and bifacial shaping systems (*façonnage*) across the Lower-to-Middle Palaeolithic boundary. Soriano shows that the 'status' and 'role' of both 'micro-contexts' of lithic production change as a function of their interrelationship through time. In the case of Gouzeaucourt level G, he is able to demonstrate that the present *débitage* systems of 'Clactonian' affinity are largely *stationary* technologies and thus supply the material for immediate domestic consumption at the sites (diversification of functional potential in terms of distinct blanks). This contrasts with the present *façonnage* systems which exhibit evidence for considerable resharpening and off-site production (suggested by the under-representation of tranchet- and volume-construction products) and is hence interpreted as a highly flexible but 'mobile' technology (dynamic and synergetic implementation of techno-functional-units/UTFs). The conclusion is that *débitage* and *façonnage* system complement each other in their 'function,' suggesting a differential use of space including technical anticipation and the spatiotemporal fragmentation of economic needs.

ration of this 'macro-context' is thought to yield a basic explanation for why particular 'micro-contexts' make their appearance.[567]

Perlès' *Économie de la matière première et économie du débitage* (1980) marks a turning point in the techno-economic discourse. Starting from the raw material question, Perlès argues that the concept of an *« économie de débitage »* merely describes a particular economic strategy – one that solves the problem of producing a toolkit diversified enough to satisfy all functional needs by means of a differential organisation of knapping. She contrasts this strategy with an alternative one, which she baptises *« économies de la matière première »* ('raw material economies'). The latter achieves toolkit diversification not by means of differentiated knapping modalities, but by differential raw material selection, acquisition, and exploitation (cf. Cretin 1996: Fig. 4; **Fig. 37**). The basic contention is that toolkit differentiation can be realised in a number of different ways (Perlès 1991b: 36f.); although the effective result – a diversified toolkit – may be broadly similar, each solution has different economic consequences and may offer distinct economic affordances (cf. Perlès 1987, 1991b, 1992). These diverse technical solutions and their consequences can in turn be charted by examining the 'texture' and 'quality' of different *chaîne opératoires* and their articulation (or lack thereof) with varying raw material substrates.

According to Perlès (1991b: 37-40), a knapper can generally decide whether she/he wants to base her/his toolkit on a set of 'undifferentiated' blanks or on a range of 'differentiated' blanks.[568] In the first case, *chaîne opératoires* tend to be structurally fairly 'simple' (*ibid*.: 38), giving the impression of a rather 'opportunistic' reduction strategy. In this scena-rio, toolkit diversification is typically achieved through a combination of blank selection and secondary modification, which together determine the morphology and function of the resulting lithic tools. Retouch in this scenario is *not fully determined* by the available blank-types; instead, it remains the primary operation for transforming blanks into the desired tools and thus to ensuring diversity in toolkit morpho-functionality. This scenario describes a *confectioning solution*.[569]

In the second case, if the knapper opts for basing her/his toolkit on a 'differentiated' pool of blanks, she/he has two contraposing options (Perlès 1991b: 38). She/he can either adopt an 'integrated' production system characterised by a single and typically rather 'complex' *chaîne opératoire* (*idem*), or can adopt a 'segregated' production system propelled by several disjunct *chaîne opératoires* of varying complexities (*ibid*.: 39).[570] In the former case, core reduction is generally 'intense' and thus typically 'ramified,' so that different blanks are available at different positions/stages in the reduction sequence. In the latter case, by contrast, blank differentiation tends to be a function of different reduction systems, whereby varying 'inter-active' and 'synergetic' relationships between these co-occurring *chaîne opératoires* are of course possible. The important point, however, is that toolkit diversification is not primarily a question of secondary modification (retouching), but instead becomes an issue of varying 'finalities' of lithic reduction methods; different methods may provide different blanks destined for different tool functions. Therefore, concordance (*« adéquation »*) between blank-types and tool-types is generally fostered, often developing into a key dimension of the 'technical logic' of the respective contexts. The implication is that the 'confection' stage (*« confection »*) of the *chaîne opératoire* is no longer decisive in terms of imposing the required final morpho-functionalities; secondary modification is thus often less invasive and strives to enhance the 'natural' morpho-functionalities of

[567] An important implication of this type of reasoning is that the 'structure' of the 'macro-context' itself, that is, the general diversity of available or present technical sub-systems and their inter-relationality, emerges as an indicator of economic functioning. For example, Middle Palaeolithic contexts of lithic technicity stand out by hosting a great diversity of distinct technological systems with differential blank-production potentials and tool-kit implications; Upper Palaeolithic contexts of lithic technicity, by contrast, appear to be characterised by a much narrower set of co-occurring technological micro-contexts (mostly laminar in character). From a 'contextualistic' standpoint, this difference alone has far-reaching implications for the nature of economic needs and their mode of satisfaction in the two timeframes.
[568] Although Perlès (1980) was the historically influential piece, I have decided to use the updated and slightly more comprehensive version here (Perlès 1991b); the 'contextualistic' inclination of the inquiry is the same; in terms of the general strategy of analysis and the main points put forward, it does not matter much which version of Perlès' model is used.
[569] The term 'confectioning solution' derives from the French word *« confection »* ('confection'/'secondary modification') which designates the stage of tool manufacturing in the *chaîne opératoire*.
[570] The perhaps most influential application of the ideal-typical distinction between 'integrated' and 'segregated'/'disjunct' lithic production systems has been provided by Bon (2000, 2002, 2010). He discriminates between an 'integrated' techno-economic system of the Protoaurgnacian and the 'disjunct' production of blades and bladelets in the Early Aurginacian. Since Bon (2002) interprets the former as preceding the latter, he essentially offers a *chronological account* of Perlès generalised scheme of techno-economic organisation within the grander scheme of the evolution of the Aurignacian in Southwestern France.

blanks rather than authoring entirely new ones.[571] As a result, the 'status' and 'role' of secondary modification itself tends to be fundamentally different. Technical systems based on the production of a diversified range of blanks to support toolkit diversification thus typically engender *flaking solutions*.

This distinction between 'integrated' and 'segregated' production systems has far-reaching implications for the economic management of the available raw material substrates (Perlès 1991b: 40f.). 'Integrated' and fairly 'complex' production systems that furnish highly differentiated blank repertoires typically rely on sophisticated knapping strategies (multiple re-organisation of reduction patterns and/or core volumes, high investment in preparatory procedures, etc.) and/or a high degree of technical 'anticipation' (e.g., structured and well-planned provisioning of high-quality raw materials), whereas 'segregated' production systems yield a much greater potential to make differential but productive use of varying raw materials.

Ideal-typically,[572] the general design of 'integrated' systems should buffer them against the effects of local variation in the quality and availability of raw material substrates.[573] 'Segregated' systems, in contrast, are not effected by such variation to the same extent; they are typically capable of embracing the diversity and locally shifting quality of raw material spectra and exploiting them to their benefit. Determination of the nature of an 'integrated' production system is therefore based purely upon the enchainment of technical actions, that is, the choices that knappers, consciously or unconsciously, make in the course of the knapping process. 'Integrated' lithic production thus usually pairs with what Perlès calls an ideal-typical *« économie de débitage »* ('blank-production economy'). In comparison, 'segregated' production systems are primarily governed by technical choices that pertain to the selection, acquisition, or management of distinct lithic raw materials – 'segregated' lithic production is thus typically associated with what Perlès refers to as an ideal-typical *« économie de la matière première »* ('raw material economy').

These categories are interpretive aids to navigate a complex technological reality and as Perlès (1991b: 41f.) readily admits are rarely encountered in their 'pure' state. Rather, they are typically observed in 'mixed' or 'hybrid' forms. Having said this, the key point is that different reduction structures are re-cast in economic terms, by evaluating different technical options and 'intra-technological' relationships bound to these structures. Technological 'design,' for example, is considered a question of

---

[571] Since 'tool' is clearly understood in maximally inclusive terms here (the category of 'tool' is itself a context-dependent category and may or may not be defined by the presence of secondary modification), this may also imply that secondary modification ceases to be a necessary means to satisfy functional needs at all. In other words, maximally economic 'flaking solutions' (see *supra*) would lead to an almost perfect concordance between blanks and tools and therefore result in a toolkit consisting primarily of un-retouched pieces. Hence, the economic corollaries of varying technical 'textures' not only have qualitative implications for the composition of lithic assemblages, but make a *quantitative* difference as well. We may wonder, for example, whether retouch-rich assemblages generally signal 'confection solutions.' In addition, we may expect that 'flaking solutions' re-negotiate the 'role' and 'status' of retouching altogether. Instead of being a means of tool individualisation, retouch may be used primarily to re-sharpen tools and/or to imbue lithic pieces with a particular culturally-mediated 'style;' retouch may also be used to differentiate between tools used for immediate 'domestic' consumption and tools that are carried around in the landscape and require elevated levels of functional 'versatility' and/or 'longevity' – a differentiation that has obvious consequences for import-export dynamics, the fragmentation of blank pools, and the mobility of different tools. The predicated logic of reasoning is undoubtedly 'contextualistic' since none of these techno-economic dimensions can be determined in isolation, that is to say, 'absolutely' or 'once and forever.'

[572] We are indeed dealing with a classic case of 'ideal-typical' reasoning here. 'Ideal-types' are to be distinguished from 'real-types' grounded in ordinary or 'average' empirical reality (the latter is typically important in 'formism') (e.g., Hillmann 1994: 348). 'Ideal-types' are always *constructed* with some interpretive purpose in mind and are consequently often purely theoretical, rational, and/or logical constructions; they regularly 'overdraw' key aspects of reality in order to emphasise their relevance (a key difference to 'real-types'). True 'ideal-types' are not just theoretical concepts that give a name to varying interpretations of the empirical evidence but also play a crucial role in the method of science itself – they bring forth a proper 'method of ideal-types' which tends to be 'hermeneutic' in character (cf. e.g., Weber 1904, 1997; Gerhardt 2001). The method consists of carefully constructing a spectrum of 'ideal-types' to characterise, arrange, order, and/or differentiate specific areas of (social) reality; quite often, the aim is to determine the relationships between different 'ideal-types' and to analyse how these are manifested (if at all) in empirical reality. 'Ideal-types,' in other words, are typically constructed either to capture the 'quality' of targeted contexts or aid the understanding of their 'texture.' The 'method of ideal-types' is a methodological cornerstone primarily of the humanities and social sciences (cf. Gerhardt 2001). For an explicit discussion of the role of 'ideal-types' in French archaeology, see Boissinot (2011: 280).

[573] This general technological design may include a strong investment in setting-up highly specific core architectures before primary reduction begins; such a procedure not only reduces the risk of failure to produce the desired range of blanks but also introduces a distinction between blanks that arise during production and those that arise during extensive core pre-shaping (again, this is a technical affordance that can be exploited to sustain toolkit diversification). 'Ramified' production system are often interlinked with particular mobility strategies since the advancement of the reduction chain yields products of different formats and sizes so that the availability of these products must be 'timed.' Similar mobility-implications also play a role for technical investment relating to the installation of 'fail-safe' core architectures (cores that are 'over-prepared'): in this case, it is likely that the pre-shaped cores themselves travel in geographic space rather than their products (this tendency is obviously inversed in 'segregated' production systems) – 'integrated' production thus often (although not always) leads to a spatiotemporal fragmentation of the technical process.

operational and *decisional hierarchies*, insofar as it is reflected in the 'structure' and 'operation' of lithic reduction systems. In general, the 'status' and 'function' of particular technical practices such as the application of lithic retouch are examined through the prism of the wider technical context in which they appear.

All of this attests to a dynamic and 'embedded' mode of classification and interpretation characteristic of a contextualistic approach to lithic data. This approach gives voice to the intuition that everything is influenced by everything else and coevally influences everything else; nothing, except for the context itself, is fixed. Again, the general strategy is to expose the 'infrastructure' of lithic technology (e.g., various reduction systems sharing the same technical context) and to determine the 'grammatical' relationships that exist between the notable parts of this 'infrastructure' in order to infer the corresponding 'finality' or 'function' (*fonction*) of the technical context. This approach is economic insofar as it seeks to illuminate the opportunities and constraints tied to different types of technicity (i.e., technical contexts). Altogether, Perlès' techno-economic approach thus exemplifies some of the key aspects of Pepper's contextualistic world theory; since her work has opened up an entirely new angle of inquiry, its conceptual and historical significance to the French tradition cannot be overstated:

> "The important point which I wish to stress here is that the articulation of the method of knapping with the tools and plain vestiges enables one not only to establish general rules of management: which morphological classes of blanks can be rediscovered in certain classes of tools; but also to recognise the priority or the priorities underlying these rules. One may therefore pass over from the diversity of knapping methods to the techno-economic diversity of lithic systems." (Pelegrin 2011: 146; my translation [the original French quote is provided in **Appendix Q.13**])

Pelegrin's map of Upper Palaeolithic laminar technology

Pelegrin's *Sur les débitages laminaires du Paléolithique supérieur* (2011), alluded to in quote above, galvanises a similar logic of reasoning: the paper provides a recent extensive survey of Upper Palaeolithic blade technology, proposing a four-part classification scheme based on previous research. The goal of this classification of lithic laminar systems in the Upper Palaeolithic is to organise technological variability in an economically meaningful way. Pelegrin distinguishes between at least four general types – types 'A,' 'B,' 'C,' and 'D' – of laminar techno-economic functioning (*ibid.*: 146; **Fig. 38**). The logic of distinguishing these four types again showcases that techno-economic research in France amounts to nothing less than interrelating 'technical rationality' and 'economic rationality;' the economic purpose or 'function' of lithic systems is therefore generally as 'situated' as their technical organisation.

Pelegrin's (2011: 146) 'type A' is characterised by a single dominant method of laminar reduction; this method can be adapted to various different raw materials and is oriented towards the production of a single generalised blank-type.[574] The method brings forth a technical distinction between 'primary' and 'secondary' products: while reduction is generally geared towards the production of the former, the latter typically arise during procedures of core initialisation, preparation, and/or maintenance. Only the 'primary' products are preferentially transformed into a single dominant tool-class or a limited set of such dominant tool-classes. The by-products of this 'primary' production – the 'secondary' products – consequently furnish the 'raw material' for the rest of the toolkit. This technical orientation towards a single generalised blank-type, however, must not lead to a dominance of the same blank type in the blank repertoire. To the contrary, quite often and rather ironically, heightened economic investment in the products of 'primary intention' results in an over-abundance of 'secondary'

[574] The emphasis here is on 'orientation.' The system does not, of course, exclusively furnish the blank-type it strives for. As already specified above, the 'orientation' of a system is its 'function,' 'directedness,' or 'purposefulness' and thus a system-level feature; it is evaluated by relating the 'structure,' 'operation' (*fonctionnement*), and 'function' (*fonction*) of a lithic technical system and theorising how 'texture' informs 'quality.' Strictly speaking, the 'orientation' of a lithic system comes into view only when its 'quality' has been understood, since only then can the internal diversity – the 'infrastructure' – of a lithic system be interpreted in light of its 'operation.' This, in turn, enables an assessment of the relative contribution of different 'infrastructural' elements to the overall 'function' of the system. To speak of the 'orientation' of a lithic system is to speak of nothing more than this matrix of inter-relationality.

products.[575] The Châtelperronian (Pelegrin 1995; Roussel 2011) and the Lower Salpetrian (Boccaccio 2005) are given as prime examples for this type of laminar reduction.

Pelegrin's (2011: 146) second variant, 'type B,' is also defined by a single constant method of reduction, but the produced blanks are even more rigidly defined. These blanks are almost exclusively fashioned and are thus typically numerically overrepresented in an assemblage. Whereas 'type A' yields 'normalised' blanks of a particular type, 'type B' supports highly 'standardised' blanks, characterised by isomorphic affinity. These blanks are not just broadly similar in shape but appear to be almost identical in outline; size differences can be attributed mainly to the timing of blank extraction (temporal position) within the reduction sequence. The result is a 'universal' blank-type which is used to manufacture all required tool-types.[576] This configuration has two consequences.

First, lithic reduction depends on well-defined core architectures that can be stabilised throughout the reduction process (e.g., by means of 'auto-preparation'),[577] which is often achieved through the installation of easily maintainable core volumes (e.g., by a relatively high investment into the early stages of the *chaîne opératoire*).

Secondly, criteria of blank selection become much more 'subtle;' they often concern the dimensionality of blanks or refer to blank features which are the result of varying reduction positions (e.g., thickness, curvature, platform configuration or relative twist).[578] According to Pelegrin (*idem*), the prototypical example for this variant of laminar production is the Upper Magdalenian of the Paris Basin (Bodu 1994).

Pelegrin's (2011: 146) 'type C' also supports a single method of laminar reduction, but this time the production is oriented towards high quantities of dissimilar blanks. The only affinity that exists between these blanks is that they share a similar structural organisation; they differ in shape, size, and other technical qualities. This type of resemblance is called 'homomorphism' (*idem*). 'Homomorphic' production is thus an instance in which continued reduction keeps the structural organisation of blanks constant but yields blanks of different techno-functional details. This strategy appears to be a compromise between 'type A' and 'type B' reduction and the author stresses the possibility that 'homomorphism' might indeed be an emergent result of executing 'type B' reduction systems in particular ways, rather than a preserved feature of the blanks themselves. In any case, differences in the geometric outline of blanks and their technical qualities constitute privileged loci of differentiation of the toolkit in this laminar system. Furthermore, 'homomorphism' of blanks is often a function of temporally well-structured reduction sequences, for instance, when distinct series of blank removal generate structure-preserving but morpho-geometrically distinct blank matrices. This type of laminar reduction can easily support 'mixed' strategies of blank selection and tool manufacturing. Pelegrin's example for a 'type C' system of laminar reduction is the Lower Aurignacian from the Bergeracois (Le Brun-Ricalens 1993).

Pelegrin's (*ibid*.: 147) fourth and last variant of laminar reduction, 'type D,' is less rigid and hosts a multiplicity of reduction methods. What is kept constant here is primarily the mode of setting up and initialising the core matrix, whereas the actual method of reduction may change as lithic knapping progresses. In Pelegrin's own terms (*idem*), the resultant production is 'heteromorphic' since each

---

575 The reason is that 'primary' products must fulfil certain quite demanding techno-morphological criteria and thus require extensive and regular preparatory interference. This produces a large amount of 'secondary' lithic material – a situation that may even lead to a quantitative over-representation of the latter. This is another reason that the 'techno-economic' approach is generally sceptical about the informational value of un-calibrated lithic quantification.

576 This would account for a prototypical example of an 'integrated' production that obtains toolkit diversification primarily by confectioning blanks of a similar morpho-technical character (*sensu* Perlès 1980, 1991b).

577 For instance, bi-directionally alternating laminar reduction with overlapping removals, if executed well, can constitute such a strategy of 'auto-preparation.' 'Auto-preparation' is nothing less than a form of 'embedded' preparation in which the gesture of knapping is not different from 'primary' production; in other words, 'auto-preparation' uses 'primary' removals to constantly rejuvenate the required surface convexities. If executed proficiently, 'auto-preparation' thus allows for exceptionally long and un-interrupted lithic reduction sequences.

578 A potentially prominent selection criterion may be the 'marginality' of blank origin on the reduction surface. The key consideration concerns the effects of surface convexity on the morphological and technical character of the retrieved blanks. The logic is 'contextualistic.' Blanks can be interrelated on a reduction surface so that they form a 'geography' (or 'topology') of reduction. Similar technical gestures may then have different effects on the details of lithic products depending on where these products have been detached. This is largely due to the effect of increasing convexities at the margins of the reduction surface: the more 'marginal' the product has been knapped, the more twisted, off-axis, and generally asymmetrical in cross-section and longitudinal view it becomes. Yet, different volume-configurations of cores have different effects on different reduction localities; it follows that these effects and the difference-making aspects of technology in terms of blank-choice can only be determined by 'contextualistic' analysis, by examining the articulation of reduction position, core architecture, convexity management, knapping techniques, and so forth.

method furnishes a series of characteristic blank-types or blank-spectra which serve to effectuate well-delineated tool-types. Cores that are the product of 'type D' reduction systems therefore typically feature fairly 'complex' reduction histories which are difficult to decipher. An alternative way to implement 'type D' is to 'outsource' the diversity of reduction modalities and to apply different methods to different cores, for instance as a function of the initial volumetric structure of the exploited raw materials.[579] The main difference between the two technical options seems to be that the first strives to 'fix' the starting conditions of volumetric exploitation by technical means, while the second regards material starting conditions as determinative for technical means. The two versions of 'type D' laminar reduction systems further imply differential 'anticipation' of economic needs and the required technical investment.[580] Pelegrin presents the evolved French Gravettian of the Corbiac-type (Pelegrin 2006a) as an example of the first version of 'type D' lithic laminar reduction.

Altogether, Pelegrin's (2011) classification of laminar Upper Palaeolithic technologies is a classic example of a contextualistic reading of the available lithic evidence. The interpretive focus is clearly placed on 'intra-technological' relations and interpretations critically dependent on the larger technical context. For Pelegrin, the key to understanding lithic techno-economies is the interaction between the methods of *débitage*, the resulting variability of blanks, and the organisation of the toolkit (including the 'status' of specific tool-types in relation to the available blanks). Almost all of the interpretive concepts summoned to characterise the laminar systems are context-specific. Moreover, the total classification only makes sense when each laminar variant is regarded as a 'micro-context' within the larger context of Western European Upper Palaeolithic laminar technicity ('macro-context'); the identified differences between the systems are difference-makers only in this larger context.[581]

With Pepper, we can conclude that Pelegrin's four different laminar variants display a radically different 'quality' due to the differential articulation of the three mentioned technical domains (i.e. methods of core reduction, resultant blanks, and tools), which then simply describe the 'infrastructural' building blocks of the identified technological variants. Their specific interlocking is thus re-cast as the 'texture' of the laminar systems in question. As a result, the laminar reduction 'types' themselves are rendered higher-level classifications based on the organisational logic of distinct relational entities:[582]

> "[The technical system] results from the functional relations between the different constituent parts which can be considered as sub-systems. The functioning ['operation'] can be defined not by the 'rules of internal relations' governing the lithic production alone, but also by taking into account the latter's finality, which means its function – two concepts which are complementary and integrated [...]. A lithic production is thus simultaneously organised by its relationships with other sub-sets of the technical system, by its finality (to make tools is the most evident), and by its means (material and intellectual)." (Valentin 1995: 24; my translation [the original French quote is provided in **Appendix Q.14**]).

Delagnes and Rendu's approach to Middle Palaeolithic techno-mobility

A final example exposing the general contextualistic propensity of French techno-economic analysis is provided by Delagnes and Rendu's oft-cited paper *Shifts in Neandertal mobility, technology and subsistence strategies in western France* (2011). Their case allows us to address the issue of mobility and the fragmentation of *chaîne opératoires* in geographic space – two interrelated topics that have already been mentioned and that have been central to the French 'techno-economic approach' since its inception (e.g., Geneste 1985, 1988, 1991 [2010]: 427-429; Texier et al. 1998; Moncel 2003; Delagnes 2010; Bachellerie et al. 2011; Moncel and Deaujard 2012; Thiébaut 2013).[583]

---

579 This strategy would conform to a 'segregated' production system trending towards a proper 'raw material economy' (*sensu* Perlès 1980, 1991b).
580 Whether this second version really represents a sub-type or rather a fifth variant of laminar reduction is largely kept open.
581 For example, the categories used to describe the 'texture' of laminar systems may have been very different if laminarity in the Levantine Upper Palaeolithic or the Indian Upper Palaeolithic had been targets of analysis and classification.
582 This point is important because it shows that technological classification is not just 'typology in disguise' as some critics argue.
583 These themes were partly foreshadowed by the influential paper *Des buts, problèmes et limites de l'archéologie paléolithique* (1972) co-authored by François Bordes, Jean-Philippe Rigaud, and Denise de Sonneville-Bordes. This paper is an interesting

Delagnes and Rendu (2011) attempt to relate Middle Palaeolithic technological functioning to mobility and subsistence, drawing on a vast corpus of lithic and faunal data from Western France. Their approach once again exemplifies the already outlined divide between 'analytic' and 'synthetic' modes of marshalling lithic evidence. They explicitly reject the idea that relevant techno-economic information on mobility and subsistence can be extracted by studying the aggregation and/or combination of discrete traits and/or attributes of individual lithic artefacts (*ibid*.: 1772f.). Techno-economic functioning – for them the key *par excellence* to reconstructing the interaction between lithic technology, mobility, and subsistence – must be examined on the level of 'technical systems.' This reiteration is important since it helps affirm that, contrary to first impressions, their approach is not at all rooted in 'Binfordian' theory and its distinction between 'logistic' and 'residential' mobility. While the authors are, generally speaking, inspired by some of the relevant concepts – a point I will return to below – their interpretative approach to the lithic data is fundamentally different.

Figure 39 exhibits the general framework of their reasoning. The guiding idea is that different lithic technological contexts that co-occur between OIS 7 and OIS 3 define well-delineated techno-economic systems which reflect varying ways of using the landscape and exploiting the animal environment. Delagnes and Rendu assume

> "[...] that a long reduction sequence duration combined with low blank versatility and a limited potential for tool maintenance or recycling suggest a low transportability of the whole production, while shorter reduction sequences associated with high blank versatility and/or a high potential for tool maintenance would be diagnostic of a higher transportability." (Delagnes and Rendu 2011: 1772f.)

They add that their approach

> "[...] considers not only tool reduction, maintenance and recycling, criteria commonly used for assessing tool transportability, but also the duration, complexity and flexibility of the reduction sequences. Considering the whole reduction sequence rather than simply the end-products, it provides basic clues for understanding how the structure of the chaînes opératoires relates to specific mobility patterns. A similar dynamic approach related to meat acquisition strategies is considered here and combined with the technological record, resulting in a systemic reconstitution of Neandertal economies." (*idem*)

In a manner consistent with the French approaches discussed above, the authors explore which behaviours, activities, and functions varying technological 'infrastructures' – the 'textures' of lithic systems – *enable* or *block*. The important point is that lithic technology is not only conceptualised as a 'problem-solver,' but at the same time emerges as an equally important 'problem-generator.' The underlying conception is that Neanderthals (and other hominins for that matter) were necessarily – and before anything else – thrown into 'pre-furnished' technical worlds; they first had to deal with and make use of what these worlds provided them.[584] Some of these 'default' technical repertoires, for example, provide means that are better suited for travelling long distances or for tracking down particular prey species, while others may be more flexible in coping with changing raw material situations. The important insight is that there is a fundamental *trade-off* between different aspects of techno-economic performance and that each technologically-mediated opportunity also has its drawbacks.

Delagnes and Rendu (2011: 1772, Fig. 5) emphasise three key sources of techno-economic trade-offs that help to make sense of technological performance and the interaction of lithic technology with mobility and subsistence. These are (i) the 'duration' and/or 'depth' of the lithic flaking and/or

historical document and showcases some of the enduring effects of the Binford-Bordes debate on French Palaeolithic archaeology.

[584] We will return to this central notion in the second part of the chapter in more detail. It can already be said, however, that the concept of 'pre-furnished' technical worlds implies a criticism of *tabula rasa* ideas of human social and material existence. The contention is that hominins lived a fundamentally socially- and materially-mediated life and hominin biology therefore does not have logical priority. Hominins are always socially and materially predefined, just as they are biologically predefined – there is, in other words, a *technological apriori* that needs to be taken into account. This view has a number of implications which I cannot draw out here. Importantly, the world into which hominins are born is not conceptualised as an empty room – capable of adjusting to any external situation in an 'optimal' manner – but is instead regarded as a partially invested, decorated, and furnished room (cf. e.g., Thévenot 2001). With Heidegger (2006 [1927]) we can say that lithic technology was always *ready-to-hand* [*Zuhanden*] rather than constantly re-invented from scratch to face new challenges. In the language of 'contextualism,' this 'pre-furnished' room constitutes the wider historical context of hominin technicity. We can say that the nature of 'pre-furnishing' likely differs between such contexts (as a function of 'novelty' and 'change'); 'pre-furnishing' in this sense can be defined as a product of the inherent 'spread' of a relevant 'macro-context,' so that key 'references' of the whole are carried through its parts and thereby connect them in time and space.

shaping sequences; (ii) the 'versatility' of the produced lithic blanks; and (iii) the technology-specific capabilities of lithic 'tool maintenance.'[585] It is generally expected that distinct technical systems will differ in their performance across these economic domains; it is in fact anticipated that divergent techno-economic configurations will be characterised by an unequal *distribution* of economic performance between the three domains. Again, the main point, conforming to contextualistic logic, is the 'situated' cross-configuration of these domains – their basic 'inter-relativity.' None of the three domains can be taken in isolation. Rather, all of them must be examined together – in their trade-off structure – to indicate system-level principles of economic organisation.

With Pepper we can say that the three domains act as sub-contexts (parts) of a larger economic whole, whose lithic technological corollaries must be determined empirically.[586] That the interrelationship between these domains – the 'texture' of the larger economic context – is expected to differ across varying contexts of technicity predicates the contextualistic categories of 'novelty' and 'change,' carrying through the principle of radical context-dependency and the root metaphor of 'situationality.' The work of Delagnes and Rendu furnishes a number of examples which help to illustrate this contextualistic condition of techno-economic inquiry. Their description and eventual comparison of Quina, Discoid, Levallois, and MTA technical systems in terms of the three economic domains exemplify this condition.

Quina reduction systems are described as 'volume-consuming' and as generally yielding a small range of rather 'thick' and often 'naturally backed' or at least 'quasi-backed' flake-blanks (Delagnes and Rendu 2011: 1777f.). These blanks are typically much wider than they are long. Blanks of this type – 'Quina-blanks' – are highly 'versatile' and, due to their rich 'raw material reservoir,' have the potential to be curated and re-sharpened over considerable timespans (*idem*). The lithic tools supported by this *débitage* system consequently afford long 'use-lifes' and intricate 'object biographies.' Because of its relatively 'simple' volumetric core structure, Quina technology requires only 'low-medium' degrees of technical investment, yet promotes 'long-term' tool maintenance, plenty of opportunities for raw material recycling, and elevated levels of technical 'ramification' (*idem*). In the authors' own words:

> "[I]n the Quina system, the flake is potentially multi-purpose since it can be exploited as a retouched or non-retouched tool, as well as alternately or successively as a core, following an order and priority that vary according to needs. In this case, recycling is not a casual practice, but a principle that determines the entire reduction sequence. The low elaboration of the flaking process is balanced by a high tool curation rate." (Delagnes and Rendu 2011: 1777)

Discoid reduction systems, by contrast, tend to afford much 'shorter' cycles of tool-use, tool reorganisation, and/or raw material re-cycling (Delagnes and Rendu 2011: 1778). Discoid technology authors more 'differentiated' blank-repertoires (one can distinguish four blank-types: 'pseudo-Levallois' points, triangular flakes, elongated *débordant* flakes and relatively wide flakes). These blanks are less 'massive' in character and their potential role as raw material reservoir is clearly reduced; that is to say, intrinsic blank-volumes are much more quickly depleted (*idem*). In return, Discoid methods can be executed rather 'reliably' in all sorts of raw material contexts and factors which are typically constraining, such as natural raw material formatting and/or quality, tend to be of marginal importance: Discoid systems perform equally well under different raw material conditions.

Levallois reduction systems require 'heightened' technical investment since a specific core architecture must be installed (hierarchy of two opposing asymmetric surfaces/hemispheres, etc.) before

[585] Many of the interpretive categories that Delagnes and Rendu (2011) mobilise in their paper – e.g., 'versatility,' 'curation,' 'portability,' 'flexibility,' etc. – are of course inspired by the Anglophone type-literature in the wake of Peter Bleed, Steven Kuhn, Robert Kelly, Lewis Binford, and others. However, this convergence – as I will detail below – is rather superficial and the way in which the authors bring these concepts to bear on the lithic evidence is inconsistent with Anglophone research. One should recall here that the mobilisation and application of specific concepts is only part of that which defines scientific approaches; more important is often how concepts are implemented and how they actually interact with data. This is precisely where the difference can be found here as well (see *infra*).

[586] Strictly speaking, this means that scholars must interrelate at least two part-whole complexes: first, part-whole articulations that characterise economic functioning are delineated; secondly, part-whole articulations that characterise the lithic technological system and that have significance for the economic system are explored. Analysis of the relationship between these two systems provides information on how the two are imbricated into each other; this last step amounts to a higher-level examination, where the two systems are re-cast as parts of their own, so that their systemic articulation within a larger and unifying whole can be determined. When French scholars talk about 'techno-economic' systems, they essentially talk about this construct of a larger and unifying whole (above described as 'macro-context').

primary production can even begin (Delagnes and Rendu 2011: 1773f.). In order to counterbalance the technical investment required (e.g., extensive preparatory procedures) and to reduce the risk of failure, Levallois systems typically have relatively 'strict' raw material requirements; they at least perform differently under varying raw material conditions. Levallois technology therefore usually presupposes higher degrees of 'planification' and techno-economic 'anticipation' – although these factors of course depend on the precise method or modality of Levallois reduction employed (*idem*).

As a result of the crucial importance of core initialisation and maintenance stages of the *chaîne opératoire*, Levallois systems tend to be 'fragmented' in geographic space and give rise to critical import-export dynamics (e.g., of pre-shaped cores and/or blanks of 'primary intention'). 'Preferential' or 'recurrent' blank-products (especially those stemming from bidirectional-recurrent Levallois systems) provide a maximisation of cutting-edge, even (or especially) without being retouched (*idem*); conversely, the typical 'by-products' of Levallois reduction (e.g., backed or quasi-backed *débordant* elements and other shaping products) lend themselves to use 'on the spot' for immediate and relatively 'expedient' domestic consumption (*idem*). Particularly large or 'massive' initialisation-products may even be exploited as core matrices to spawn independent production chains 'on-flake' (*ibid.*: Fig. 2).

All of these features foster an internal structural division between relatively 'mobile' and rather 'stationary' Levallois products. Moreover, the general organisation of Levallois technology affords the 'optimisation' of patterns of blank-tool convergence (*« adéquation »*). The result is a highly 'differentiated' spectrum of comparatively 'specialised' blanks, whose economic versatility remains rather 'limited.' Nevertheless, some Levallois production methods – e.g., selected 'recurrent' and 'laminar' modes of volumetric exploitation – yield blanks with an 'intermediate' potential for 'tool maintenance' (cf. Delagnes 2010).[587] It is this particular configuration of opportunities and constraints that defines the economic signature of technical systems we call 'Levallois.'

The MTA (*Moustérien de tradition acheuléenne*), finally, combines one or more of the described *débitage* systems with a specific mode of bifacial production (*façonnage*) (Delagnes and Rendu 2011: 1774-1777); this production typically yields so-called cordiform 'MTA bifaces,' which clearly exhibit elevated levels of mobility as shown by the spatial 'fragmentation' of their production, re-sharpening, and/or re-cycling (cf. Soressi and Hays 2003; Claud 2008). In the MTA, a relatively 'high' degree of 'technical investment' – attested to by the construction of the respective bifacial volumes (*façonnage*) and the maintenance of their morpho-functionality – is thus correlated with a generally 'high' potential for 'tool maintenance' (Delagnes and Rendu 2011: 1778f.). Depending on the associated *débitage* system(s), this economic signature can be variously enhanced and/or supplemented – *débitage* systems may either 'complement' or 'synergise' with the existing bifacial production. The result is a highly 'flexible' super-system that buffers against mobility stress and enables a variable division of activities in space. The technical architecture of the MTA thus tends to be fairly 'complex' and this complexity should be reproduced by the general patterning of behaviour documented within this context.

The line of reasoning presented thus far encapsulates a 'user-centred' approach to lithic technology: technical systems are conceptualised as self-regulated complexes of economic trade-offs which allow their users to interact with the environment in particular ways.[588] The important point is that these self-regulatory trade-off systems are used to define the economic performance characteristics of the technical systems in question. 'Economic performance' is therefore understood not simply in terms of specific lithic artefact properties and/or their 'absolute' instrumentality, but instead as a function of the systemic interaction between the 'structure,' 'operation' (*fonctionnement*), and 'function' (*fonction*) of a technical whole. This technical whole does not simply exist 'passively' in the world, 'reacting' to the economic needs imposed by external conditions (e.g., environmental, demographic), but *actively* shapes the convergence of hominins and their exteriorities.[589] Hominin-environment interactions

---

[587] Delagnes and Rendu (2011: 1773) discuss Levallois methods and non-Levallois laminar methods in tandem because they are systematically associated with one another – a fact that I have omitted in the present reconstruction.

[588] It is no coincidence that the term 'trade-off' is rarely used in the French literature; instead, scholars tend to invoke the notion of *« échange »* in order to characterise the respective relationships among the parts of a technical whole. This again signals that 'trade-offs' are really analysed in a 'synthetic' manner – as a result of particular part-whole dynamics – and that economic trade-offs are simply regarded as a special type of inter-relationality typifying the 'texture' of a whole.

[589] This conception assumes two things: first, that technology has some sort of *agency* that established a bi-directional hominin-technology dialogue, and secondly, that hominins will be 'smart' enough to quickly discover the potentials and drawbacks of a given technological system (see *infra*).

are regarded as *technologically mediated*.[590] Lithic technology is essentially seen as an artificial 'user-interface' which, if operated by experts, can be customised in a number of ways to solve a number of different problems; however, because the systems themselves tend to be rather 'complex,' a portion of the issues to be solved is always home-made, that is, derives from the self-created constraints of particular user-interfaces.[591]

The 'pro-active' dimension of technological problem-solving can be illuminated by the various 'opportunities' provided by the interplay between technical 'texture' and 'quality.' These 'opportunities' may be characterised as *technological affordances*,[592] defined as features, aspects, or sub-structures of a wider technological system that 'invite' users to take advantage of them to reach certain goals under certain circumstances. In other words, technical 'affordances' help theorise which part of a technical 'texture' is good to accomplish *x* and thus to satisfy the need *y* if required. The notion of 'affordance' is thereby always a relational construct: its epistemic task is to sort, arrange, and signify other relations. It thereby opens the gates to a 'soft' ecology approach to lithic technology and is perfectly consistent with contextualism's central tenets:[593]

> "[…] The groups that favored the Levallois débitage method, or those that manufactured Quina scrapers or bifaces, would have been constrained by their technical traditions. In response to possible shortages of local, high quality raw materials in sufficient quantities (anticipated or not), they would have carried with them the minimal equipment necessary for short expeditions and seasonal movements. Because their knapping method was more dependent on the quality and dimensions of available raw material volumes, these groups opted to transport part of their necessary equipment. At the other end of the spectrum, the groups who used the Discoid *sensu stricto* method were less dependent on the quality and dimensions of available raw materials, and thus did not encumber themselves with such equipment when they moved across long distances. The flexibility of this débitage method thus freed these groups from the technical constraints imposed by the raw materials available to them." (Thiébaut 2013: 15; original italics)

The next step in the analysis is to specify the relationship between the documented lithic systems and the corresponding subsistence practices. The goal here is two-fold: on the one hand, the technological findings are to be calibrated against the implications of the faunal record; on the other hand, the subsistence-implications of the technological conclusions are to be tested against the available evidence. Again, this strategy conforms to a combination of 'direct verification' and 'qualitative confirmation' – modes of knowledge corroboration proper to contextualism.[594]

The authors relate the structure of the technical systems to the structure of the associated faunal assemblages to derive specific mobility profiles (Delagnes and Rendu 2011: 1772f.); these are intended to capture the interaction between the former and the latter. Mobility is thus re-cast as a not directly observable parameter of past reality that must be inferred from two directions: from the technology-specific potential to support 'increased' or 'decreased' mobility, and from prey-specific ethologies that call for these types of mobility and require specific hunting tactics. The authors thus seek to identify a mobility system (including activity and site organisation) that illuminates why and how prey mobilities – mapped on a spectrum from 'mobile' to 'stationary' – are regularly associated with particular technology-specific mobility potentials. As an auxiliary factor to help calibrate the respective technical 'affordances' against the relevant animal behaviours, a distinction is made between relatively

---

[590] This moment of 'mediation' dispels overly 'mechanistic' conceptualisation since it undermines the idea of a direct 'contact zone' between lithic technology and environmental make-up. The rejection, explicit or not, of 'mechanistic' explanations that emphasise 'final' or 'ultimate' causes is at least symptomatic of a 'contextualistic' stance.

[591] This is the 'curse' of technicity to which we will return in the next part of the chapter.

[592] 'Affordances' are *possibilities of action* that do not arise from the intrinsic motivations and/or needs of the actors alone (Gibson 1977, 1979; cf. Withagen et al. 2012). The notion thereby links approaches that emphasise the 'activity' of material culture ('agentivity,' 'potentiality,' 'materiality,' etc.) to those that stress the importance of human motivation and choice; it paves the way for a *user-centred* approach to technology (Gaver 2001; Hutchby 2001), which can be contrasted to 'actor-centred' or 'environment-centred' approaches. The following statement exemplifies a key aspect of an 'affordance-based' approach to technology: "[i]n contrast to recent sociological emphases on the social shaping of technology, [I] propose[] and illustrate[] a way of analysing the technological shaping of sociality […] [I] argue[] for a recognition of the constraining, as well as enabling, materiality of artefacts" (Hutchby 2001: 441). Although French *chaîne opératoire* approaches do not share all of these respective positions, some of the mentioned views and inclinations are implicitly embraced.

[593] For an illuminating discussion of the role of 'affordances' in *« actions outilées »* ('tool-mediated action') and the critical distinction between 'natural' affordances – grounded in the biology and physiology of organisms – and 'artificial' affordances – anchored in human-endowed technical worlds – see Sigaut (2012: 118-122).

[594] See Chapter 2 for details or refer to Pepper (1942: 272-278).

'solitary' and relatively 'gregarious' species.[595] The examination of the associated faunal spectra establishes part of the wider context of lithic technology (its 'macro-context'), which, in turn, guides the analysis of technological performance under varying animal circumstances.[596] It follows that the assessment of the differential capacity of lithic technology – its intrinsic 'pros' and 'cons' – to follow, intercept, and/or chase down particular animals requires serious evaluation of the ways in which the two 'micro-contexts' – 'animal' and 'technical' – *co-produce* each other.

Drawing on Pepper, we can say that a successful 'fusion' of the technical and animal 'micro-context' provides an explanation for why the two exist side-by-side. Only evidence for a shared super-structural 'quality' of the two 'micro-contexts' can illuminate why they can be regarded as 'micro-contexts' of the same 'macro-context' in the first place. To demonstrate that the two 'micro-contexts' condition each other consequently implies the elimination of all blocked 'strands,' which would have rendered their cohesiveness rather unintelligible. By relating the economic implications of the lithic context to the technological implications of the animal context, the authors show that the resulting super-context is 'workable' and advances our understanding of past reality; this approach is multi-directional and resonates with contextualism's proper theory of cognitive criticism.

Delagnes and Rendu (2011: 1773-1778) identify four distinct mobility systems which they organise in two groups of two (**Fig. 40**). Levallois-laminar and MTA technical systems are interpreted to promote 'non-selective' hunting strategies, while Quina and Discoid-denticulate systems are considered to encourage more 'selective' hunting strategies.

Levallois technology is shown to be typically associated with assemblages yielding a wide variety of 'non-migratory' prey species; this likely indicates 'low-medium' mobility and that hominin movement was probably more strongly dictated by raw material requirements than by animal behaviour (Delagnes and Rendu 2011: 1774, Fig. 3). The MTA is interpreted as a sort of leapfrogging system, where hominin groups alternated between larger 'multi-purpose' campsites (involving high-investment installations such as campfires) which have produced highly variable faunal assemblages (some of which indicate that even 'solitary' animals were occasionally targeted) (*ibid.*: 1777). The distinction between 'stationary' *débitage* systems and a 'highly mobile' *façonnage* system in the same context is thought to be consistent with the implied 'intermediate' level of mobility.

In contrast, Quina technologies seem to be regularly associated with a 'monospecific' fauna, in which reindeer is the dominant prey (Delagnes and Rendu 2011: 1777f.). Here, selective hunting meets a 'gregarious' and fairly migratory species whose seasonal movements are largely predictable. The fact that Quina-bearing sites represent a mixture of true campsites and task-specific satellite-sites is seen as further indication that the corresponding mode of operating in the landscape was based on 'high' levels of mobility: hominins are depicted as 'residential' reindeer-followers who established 'logistical' camps around one or more seasonal basecamps (*ibid.*: Fig. 4). The presented arguments for liking Discoid-denticulate systems and their target prey mobilities are not much different. Discoid-denticulate systems are typically associated with faunal assemblages dominated by bison and horse, two seasonally migrating taxa. This is regarded to reflect a selective hunting strategy which presupposes elevated levels of mobility. The corresponding settlement profile is consistent with this evidence, also pointing to an interlinked system of campsites and more task-specific sites (*ibid.*: 1778). The reconstructed 'high-mobility' pattern is thus broadly similar to that reconstructed for Quina systems. Both systems are consequently interpreted as largely equivalent solutions to similar economic problems. The resultant character and chronological positioning of the four techno-economic macro-

[595] Why is this categorisation not 'dualistic'? Two answers can be given: first, the categories represent 'ideal-types' which are formulated for heuristic and methodological reasons, not to trace the ontological structure of reality (see *supra*); secondly, with Pepper one can state that the categories aim to capture the 'qualities' of their 'micro-contexts,' which are then translated into 'strands' (and perhaps even 'references') to analyse their interrelationship in their resulting new 'macro-context;' 'ideal-typical' categories are hence nothing more than interpretive aids to determine the role of 'micro-contexts' in their 'macro-context' and to understand how 'they tangle into one another' (or do not) as 'strands.' The results do not need to be affirmative. 'Disorder' is an important category in 'contextualism' and 'strands' may be incompatible; as long as local 'disorder' explains global 'operationality,' this does not pose a problem.

[596] This reflects the fact, already alluded to above, that the 'affordance' structure of technical systems can only be evaluated in relation to its wider context of significance – in the present case: the animal context. The analysis is thus highly context-sensitive by definition.

systems are regarded to refute simple and uni-directional models of Neanderthal behavioural evolution in Western France between OIS 7 and OIS 3 (*ibid.*: 1789).[597]

All of this shows that Delagnes and Rendu's total account is clearly characterised by descriptive and explanatory 'thickness.'[598] The account is 'thick' because the boundaries between meticulous description and substantial interpretation are often blurred and the ordering of relationships turns out to be the authors' core business.[599] 'Thickness' is a contextualistic category and responds to the need to map the details of contexts and even super-contexts as comprehensively as possible; this, again, requires consideration of each context's 'texture'-'quality' dynamics, both in terms of 'novelty' and potential 'disorder.' A consequence of this contextualistic 'thickness' is the multi-directionality of inference, categorisation, and interpretation that characterises *Shifts*. The emphasis clearly lies on articulations, co-constitutions, inter-constraints, etc. – specific relationalities that must be identified, arranged, and assessed.[600] This is consistent with the idea of 'weak' determination and the consolidation of a multiplicity of potentially equally important factors to shape reality. The epistemological stance is hence anti-foundational, which again illustrates that contextualistic reasoning cannot accept the fixation of reality, not even a fixed structure of determination (e.g., a 'ladder of causation');[601] contextualistic realities tend to be *entangled* and *messy*. This conceptual orientation is made explicit by the authors themselves:

> "[…] The picture that emerges from our data is more relevant to a complex and multicausal explanation of the diversity observed in the archaeological record than to a single explanation, whether cultural, functional, chronological or environmental." (Delagnes and Rendu 2011: 1779)

Another observation is important: the positioning of any of the four technical systems in Delagnes and Rendu's economic triangle *depends entirely on the positioning of all other technical systems within it*.[602] The signification of system-specific trade-offs, in other words, is a comparative assessment and therefore always *relative* to the wider 'context of comparison.'[603] None of the three identified sources of economic variability can be described 'absolutely' – this fact is directly reflected in the relativist terminology applied (e.g., 'high,' 'low,' 'increased,' 'decreased,' 'elevated'/'heightened,' 'reduced,' etc.). This not only confirms that lithic systems are conceptualised as sub-systems ('micro-systems') which are examined internally and then compared to other sub-systems to determine the relevance of the discovered 'infrastructural' features, but also highlights again that everything remains context-dependent – i.e., nothing can be fixed before a context has been analysed. This pattern of thought is highly characteristic of French lithic research in general – it is predicated upon Leroi-Gourhan's *« technologie comparée »* (cf. Leroi-Gourhan 1949; de Beaune 2011; Soulier 2015: 25f.) and was later taken up by approaches in the wake of *« Technologie préhistoire »* (cf. Tixier et al. 1980; Audouze et al. 2018), the mother of lithic technological research in France.

A similar perspective is reflected in what has become the standard reading of the Mousterian techno-economic architecture of Western Europe (e.g., Bourguignon et al. 2006; Meignen et al. 2009; Dawson et al. 2012). The result is a cross-tabulation, in which the economic characteristics and trade-offs of different technical systems are generalised (**Fig. 41**).[604] This table is inherently comparative: it

[597] The contention here is that a 'multi-linear' evolutionary scenario is much more likely given the chronological juxtaposition of Quina and Discoid-denticulate systems at the end of the chronological sequence (MIS 4-3). In addition, the authors explicitly ponder the question of whether Quina and Discoid-denticulate systems are to be regarded as two *culturally distinct* responses to very similar economic needs (Delanges and Rendu 2011: 1780). A linear or gradual evolutionary scenario is also problematic because the MTA is intercalated between the Quina and Discoid-denticulate complexes and it is not evident how the resulting sequence is illuminated by such a scenario (*idem*).
[598] See Chapter 2: **Box 8**.
[599] That interpretation, analysis, and description are somewhat blurred is signalled by the fact that lithic, faunal, and settlement data are presented and interrelated in a single paragraph for each techno-economic system.
[600] This inclination is in itself characteristic of 'contextualistic' inquiry. It is expressed in the fact that Delagnes and Rendu quasi-symmetrically relate the structure of lithic assemblages to the structure of settlement organisation and faunal assemblages. It is also notable that the starting point of this analysis is largely arbitrary and one therefore typically starts from wherever the evidence is richest (in other words: the fact that the authors embark on the analysis from the perspective of lithic technology is no argument for the general explanatory primacy of lithic technology).
[601] From a 'contextualistic' perspective, even 'determination' is confronted with 'novelty' and is thus potentially context-dependent.
[602] Even the addition of a single technical system would change the larger context of technologies and thus potentially the signification of the relative features that define this larger context.
[603] In *Shifts*, this wider 'context of comparison' is simply the wider context of OIS7-3 Middle Palaeolithic technicity.
[604] This cross-tabulation can be interpreted as a specification of the structure of economic 'affordances' provided by each technical system.

juxtaposes 'investment in core shaping and/or maintenance,' 'degree of predetermination of desired endproducts,' 'degree of normalisation of desired endproducts,' 'potential for blank/tool re-sharpening,' 'degree of ramification,' and 'blank productivity' of various technical systems. Taken together, the relative weight of these features, derived from the 'infrastructural' organisation of the respective technical wholes, is thought to define to the economic 'qualities' of the latter.

These 'qualities' are *relative* in a dual sense: each systemic feature is determined by its relationship to all other features of the same system, but the specific quality of each feature also depends on the quality of all other features of the same category that exist within the same wider context of technicity (in the present case: the 'Mousterian' of South-Western France). This pattern of thought clearly reiterates what has already been found, namely that each technical system is typically identified as a context of its own ('micro-context'), but also participates in the broader technical context of its period/epoch ('macro-context'). To this effect, the tabulated economic features of the listed Mousterian technologies are clearly context-sensitive. They are 'objective' insofar as each systemic configuration of features is consistent with the system's placement in the context of all other systems – the relative placement of each system, in other words, removes all interpretive obstacles and thus 'works.'[605]

5.1.4 *What's in a type? Morpho-types, techno-types, and 'technological typologies'*

Another field in which basic contextualistic assumptions feed into French lithic research is typology, which is a contested arena. The term conceals substantial variability in how types are constructed and interpreted. The main issue, as we have already seen in Chapter 2, concerns the role and function of classification and typology in knowledge-formation. Not all typology is the same in this respect. A crucial issue is that typological reasoning in the French tradition appears to be largely 'non-taxonomic,' extremely dynamic, and highly flexible, and thus conflicts with the 'formistic' interpretation of types which prevails in most Anglophone lithic research. French scholars have come to reject the 'catholicity' of types, including the idea that typology represents a viable means of directly mapping intra- or inter-assemblage variability.[606] The reasons are manifold and partly historical, partly epistemological – yet, most of them are a consequence of the opposition drawn between 'typology' and 'technology' (cf. Otte 1991).

The 'typology'/'technology' distinction reiterates the 'synthetic' proclivity of French lithic research: 'typology' carves out discrete parts in the world, whereas 'technology' concerns the structure of wholes. The tension between 'typology' and 'technology,' characteristic of the wider French lithic discourse (e.g., Boëda 1991: 38-40; Forestier 1993: Fig. 16, 1998; Bourguignon 1997; Lenoir 2008; Valentin 2008b), therefore reflects the ever-present struggle to come to terms with part-whole dynamics in lithic research. The implication is that 'typology' can never be the final answer to technological questions (cf. Boëda 1991: 38); 'technology' is always *more than typology* – accordingly, it cannot be reduced to a mere question of types.

The rejection of typology as the central method of lithic inquiry is inextricably bound to the 'technological revolution' incited by André Leroi-Gourhan and Jacques Tixier between 1970 and 1990 in Paris (Texier and Meignen 2011; Audouze et al. 2018). A key objective of the time was to overcome the interpretive impasse created by 'La méthode Bordes.' Before the 'technological turnover,' there were essentially two contesting lithic approaches, both built on a 'Theory of Types.' The first was grounded in classic 'Bordian' type-lists (Bordes 1950, 1961a, 1961b; Sonneville-Bordes and Perrot 1954, 1955, 1956a, 1956b; Sonneville-Bordes 1960), the second in the 'analytic' methodology of Georges Laplace (1966a, 1966b, 1968, 1972). While the Bordian approach relied on a *« typologie morphologique »* ('morphology-based typology'), Laplace's approach was based on a *« typologie analytique »* ('analytic/trait-based typology') (cf. Lippé 2012: 170; Demars 2011).[607] However, Laplace's

[605] This again takes up the 'soft ecology' inclination of French lithic research. The 'quality' of each 'micro-context' is controlled by the 'qualities' of its immediate surroundings (other 'micro-contexts'). Metaphorically, one may therefore say that the resulting relative economic positioning of each 'micro-context' corresponds to its 'economic niche' in a wider context of technicity.
[606] This does not preclude the use of typology as a 'quick-and-dirty' means to characterise and compare lithic assemblages; typology thereby acts as an initial 'proxy,' but the results require further empirical examination and corroboration.
[607] A strict opposition between Bordes' *« typologie morphologique »* and Laplace's *« typologie analytique »* is only partly adequate since Bordian typology is not exclusively grounded in the morphological aspects of lithic artefacts, but also took into account some of their technical characteristics. Arguably, Bordes' typology was grounded in a 'synthetic' appreciation of artefact-

explicitly 'atomistic' and attribute-based approach to lithic typology – an example of 'taxonomic' reasoning as I have defined it in the previous chapter – was quickly marginalised by the Bordes and hence disappeared from the epistemic core of the French tradition (Bon 2009: 84-88; Lippé 2010; Plutniak and Tarantino 2016).[608] Tixier's (1976; 1980) forceful critique of the quantitative presupposition that had dominated most of the 'Bordian era' simply amplified this effect (cf. Perlès 2016), removing all seeds of 'taxonomic' or otherwise strongly 'typological' reasoning from the French lithic research enterprise (e.g., Perlès 1987, Boëda 1994). 'Typology' would now serve 'technology,' and not the other way around (cf. Geneste 1985: 171, 249-251, esp. Fig. 72).

The result is a *pragmatic* treatment of types. Their methodological role in French technological research is restricted to casting light on the contours of varying *chaîne opératoires*. 'Typology' is used to enable the analysis of relationships among lithic types and thus to illuminate some 'infrastructural' features of lithic technology. Typology, in other words, has become a tool used to investigate the 'texture' of technical systems rather than to characterise their 'quality.' Typically, typology either aids in charting the 'structure' (*structure*) or the 'function' (*fonction*) of a technical system (*sensu* Sigaut 1991), but rarely captures aspects of them both; typology is generally regarded as only poorly equipped to address the problem of systemic 'operation' (*fonctionnement*). It is typically seen as capable of describing merely a part of the systemic articulation which French lithic experts seek to unveil.

The idea, again, is that different 'textures' may support different lithic types and *particular types may therefore only be useful for understanding particular technical systems*. Different types may also elucidate different levels of technological organisation and types must thus always be calibrated against their whole. This 'resonating' linkage between the types that are mobilised and the wholes which the types are supposed to illuminate is characteristic of the use of typology in French technological research. It is a classic expression of the 'inseparability' tenet permeating contextualistic thought,[609] motivating a somewhat 'dialogical-dialectical' mode of typology-making.[610] It is therefore not surprising that types are regularly formed under 'hermeneutic' and 'dialogical' conditions of analysis. Types are not simply inferred; their legitimacy must be defended by argument and interpretive rationality.[611]

From this perspective, the transition from the 'typological era' (Bordes) to the 'technological era' (Tixier) can be said to correspond to a fundamental shift in the role and status of typologisation in lithic research. The transition has considerably weakened the 'semantic' role of types and fortified their 'syntactic' role in lithic inquiry. That the Bordian typological system is still widely used reflects a concern with precise and consistent terminology (e.g., Brézillon 1968) – the aspiration of scholars to use the same expressions and even the *same words*. The distinction between 'words' and 'language' is significant here. 'Words' fix a certain meaning, but some words are polyvalent insofar as their meaning depends on the sentence-context; speaking a 'language' implies knowledge of the rules that connect words and sentences in meaningful ways (grammar, syntax, narrative style, etc.), knowledge of the various semantic connotations, and the ability to render each utterance intelligible in its context. This is exactly the difference between 'typology' and 'technology' in French lithic analysis: 'typology' provides the words and sometimes parts of the sentences, while 'technology' constitutes the language in which they make sense (**Fig. 42**). 'Types,' in a similar vein as words, enable the pre-organisation of the lithic evidence and present a means of easy communication. Their role is 'syntactic' in this sense. But in order to elucidate aspects of technological organisation, types always require further contextual interpretation.[612]

wholes, while Laplace's approach was strictly 'analytic' and as such mainly concerned with building up types in 'bottom-up' fashion, via the detection of patterned trait-associations.

[608] Instead, Laplace became influential in both Italy and Spain – Laplacian thought was literally exiled to other countries.

[609] See the description of 'contextualism' in Chapter 2.

[610] See Chapters 2 and 3 for the significance of this mode of analysis in lithic research guided by 'synthetic' world theories.

[611] The implication is that 'Bordian' typology primarily serves a *descriptive* purpose (e.g., Le Brun-Ricalens1993: 130f.), so it logically precedes *technological interpretation*.

[612] Guillaume Boccaccio (2005: 40), for example, explicitly contends that 'technology permits the understanding of the morphogenesis of lithic types, while typology facilitates the comprehension of certain technological choices.' This illustrates that the cross-calibration – or *contextualisation* – of 'typology' and 'technology' is really what promises to deliver comprehensive lithic knowledge.

The contextualistic orientation of typological practice in the French tradition is perhaps best reflected by the *plurality* of lithic type-concepts that are put forward.[613] Classic 'Bordian' tool-types are thereby merely one way to employ typological reasoning, perhaps a rather marginal one. They are complemented by many other types, many of which are much more interpretive; these other types serve different analytic purposes and typically radicalise the aspect of context-dependency. This typological 'context-dependency' can be discussed from three different perspectives.

First, 'Bordian' tool types may constitute the 'macro-context' of typologisation. The idea then is to look for technical, technological, and/or techno-functional distinctions within a given 'Bordian' type, in order to further divide it into potentially meaningful sub-categories – e.g., relative to the functional potential of a cutting edge, the mode of manufacturing, and the volumetric structure or type of the original blank (e.g., Bonilauri 2010; Nicoud 2011: Chapitre 3.5; Weyer 2016). This practice establishes new 'micro-contexts' which can be related in turn to other 'micro-contexts' within the same technical system. The strategy is 'dispersive' and the aim is the *proliferation* of situated facts, so that the 'texture' of lithic technology comes into clearer focus. Instead of sub-dividing 'Bordian' categories, scholars may also aggregate types into larger, more generic types.[614] The aim is the same: to link the constructed types to other 'infrastructural' features of the technical system in order to determine its internal organisation and regulatory principles.

Similarly, other features of the *chaîne opératoire* may be defined as a 'macro-context' of typologisation; for instance, researchers may devise lithic types in relation to distinct stages of reduction – i.e., how many types are associated with a given stage and how they are characterised (cf. Boëda 1988) – or relative to different blank-matrices (e.g., Bourguignon 1997; Soriano 2000). Typology then depends on the construction of other subordinate typolo -gies, and types which are considered technologically meaningful are often found to be the product of the relationship between two or more basic types (e.g., blank-type, tool-type). The qualities and features relevant to grouping particular lithic artefacts together thereby depend entirely on their technical context (cf. e.g., Chevrier 2012: 154-160; Carmignani 2017: esp. Figure 13, 23f.; **Fig. 43**).[615] Typology thus requires the specification of a context, which is typically defined as a function of the 'quality' and 'texture' of the encasing *chaîne opératoire*.

This strategy again reveals the radical 'dispersive' potential of French technological research since types may be multiplied endlessly, leading to an ever-increasing proliferation of fact. It follows that the construction of types cannot itself constitute the ultimate goal. Types are always *means*: enabling features of inquiry which themselves say very little. A type is useful not because it embodies a statistically significant difference in the world, but because it allows scholars to make 'infrastructural' connections that are otherwise overlooked. Typology is consequently nothing more than a device to find consistent webs of intra-technological relations and to remove all interfering obstacles of interpretation. Types are thus constructed and mobilised in a manner consistent with the mode of knowledge corroboration proper to contextualism.

Secondly, assemblages, or the wider technical sphere of a given period or epoch (i.e. Mousterian, Aurignacian, Western European Upper Palaeolithic, etc.), may delineate the 'macro-context' of typologisation. The objective here is to give structure to highly variable entities and to identify their constituting lithic 'micro-contexts.' In contrast to the foregoing variant of typology-making, the target is no longer lithic artefacts, but higher-level entities such as 'technical systems.' We may in fact say that the talk about different 'lithic technologies' in the French literature has its origin in this variant of typological reasoning. The respective 'technologies' or 'technical systems' are the 'texture'-giving substructures of assemblages or periods/epochs. Pelegrin's (2011) four-part classification of Upper Pal-

[613] It is likely that it is precisely this plurality of type-concepts, all of which serve a distinct epistemological function (see *infra*), that has caused so much irritation and misunderstanding in the Anglophone world. The charge of 'over-formalisation' prominently put forward by Bar-Yosef and Van Peer (2009) and the positive responses in the commentary section of their *Current Anthropology* paper only confirm this fact and show that the issue hit a nerve. In fact, it seems rather common-sense among many Anglophone lithic scholars to believe that 'technology' is merely some obscure sort of 'neo-typology' and thus 'over-formalises' the available evidence to this effect (e.g., Tostevin 2011b: 352, 359-362, 2012: 94-97; Monnier and Missal 2014: 62). This assessment is ironic given the apparent 'contextualistic' architecture of French lithic typologies including the fact that 'types' essentially help to unearth technical relationships and thus ensure that technological analysis works (see *infra*).

[614] Scholars may of course also aggregate types into macro-types and then subdivide them again based on some of the same features mentioned above.

[615] Cf. Chevrier (2012: 175-262, 304-377 433-534, 582-669) for a detailed application of 'techno-type'-based classification of African and Levantine Acheulean bifaces.

aeolithic laminar reduction technologies in Western Europe is an example of this mode of typology-making. More generally speaking, this meta-perspective on types also motivates scrutiny of the possibly changing 'status' of typology in varying technical 'macro-contexts' (e.g., Valentin 2011: 47). It should be obvious that this inclination is deeply contextualistic since the role of typologisation itself is suspected to change relative to the 'quality' of different contexts. Even the utility of typology in knowledge-formation is thus thought to be mutable, that is, context-dependent.[616]

Thirdly, specific production systems may be identified as 'macro-contexts' of typologisation; the aim is then typically to find lithic types that are 'diagnostic' of the respective systems. Their recognition, consequently, depends on the 'texture' and 'quality' of the technical system of which they are a part, which are is often referred to together as the 'finalities' of the system (e.g., Valentin 1995: 25f.). Specifically shaped (i.e. convexity, twistedness, laminarity, etc.) and prepared (i.e., directionality, types of negatives, etc.) crested pieces might be regarded as such 'techno-types.' Techno-types are thus types that have been constructed with reference to their technological role and implication – they are *pars pro toto*.[617] As such, they are distinct from 'morpho-types' which are primarily defined by their morphological and shape-related attributes. Again, it is typically the interaction between 'techno-types' and 'morpho-types' which defines a particular lithic technology.

Taken together, these three perspectives on context-dependent typologisation illustrate that 'typology' in the French tradition depends on a *global* assessment of the technical context under consideration; in the case of a lithic assemblage, 'typology-making' cannot therefore be separated from the *technological reading* (*« lecture »*) of the assemblage-totality (cf. Geneste et al. 1997). As such, typologisation is a 'multi-stranded' endeavour since various different types must be marshalled in order to determine the structure-giving relations making up lithic technologies. The lithic types that French scholars construct and analyse thereby reflect the general conception that technical systems are complex and multidimensional entities (e.g., Forestier 1993: Fig. 1; Ducasse 2012: 151), which is largely at odds with the 'analytic' definitions of types that predominate in Anglophone lithic research.[618]

Generally speaking, the 'technological approach' (*sensu* Tixier et al. 1980; Pigeot 1983; Perlès 1987; Pelegrin et al. 1988; Boëda 1994; Pelegrin 1995; Inizan et al. 1999 [1995]) sharply distinguishes between 'Bordian' types – largely restricted to tools, cores, and some special blanks – and 'technological typology' in the wake of Tixier (2012 [1978]: 135f.). Whereas the former groups together lithic objects that share crucial aspects of their 'artefactuality,' the latter groups together objects that occupy a similar place or play a similar role in their *chaîne opératoire*. This is why 'technological typology' may be informed and/or solidified by experimental knapping (e.g., Roche and Tixier 1982; Binder and Pelegrin 1983; Boëda and Pelegrin 1983, 1985; Texier 1984; Geneste and Maury 1997). 'Bordian' and other classic typologies, by contrast, they tend to be indifferent to experimental knapping insights and typically don't benefit from them. This difference represents another locus where French lithic typologies display their contextual constitution; if the construction of types can be easily and productively informed by general insights into the functioning of lithic reduction, it exhibits a critical 'openness' and contextual sensitivity.[619]

---

[616] Boris Valentin (2011: 47), for example, invokes the possibility that the difficulty of typologically organising pre-Upper Palaeolithic, especially Mousterian, lithic assemblages is rooted in the technological nature of these complexes; different technological contexts, in other words, may have different *typological consequences*. The fact that Upper Palaeolithic technologies support well-differentiated and recognisably distinct 'types' can then be seen as a result of their distinct techno-economic architecture. Types, then, become also much more susceptible to reflecting regional variation (e.g., Klaric 2007). See also the discussion by Slimak (2006) on the status of burins in Middle Palaeolithic assemblages.

[617] See for example Crassard's (2007: 143-151) reconstitution of the 'Wash'a' *débitage* system of laminar production in Southern Yemen.

[618] 'Analytic' definitions of types, for example, stress that types are clusters of attributes (e.g., McPherron 1994: 42). Even the conventional 'analytic' distinction between 'monothetic' (types as clusters of objects) and 'polythetic' (types as clusters of attributes) typologies (cf. Adams and Adams 1991: 226) does not fully apply to the kind of typologising we regularly observe in French lithic analysis.

[619] This 'openness' of typologisation for experimental knapping insights is another reason why experimental knapping has traditionally occupied such a central place in French lithic research. It not only provides general knowledge about the process of knapping, but also has a 'difference-making' potential for how types are constructed and interpreted. 'Technological typology,' more often than not, is a typology calibrated against knowledge derived from experimental knapping; this last aspect indicates that typology-making often depends on an experimentally derived *prejudice-structure of knowledge* – on 'pre-knowledge' from another domain of practice. This general configuration carries a 'hermeneutic' undertone since technologically meaningful types can be constructed if, and only if, lithic artefacts are interpreted against the background (*horizon*) of subjective and inter-subjective knapping experience. This 'hermeneutic' inclination is a strong indication for the 'contextualistic' nature of typology in the French tradition (see Chapter 2 for the link between 'contextualism' and 'hermeneutics').

It is therefore the constant tension between classic typology and 'technological typology' – i.e., the interplay or incompatibility between the two – that turns out to be productive in French lithic research (cf. Pessesse 2002; Lenoir 2008). An example is the concept of 'D/discoid' which can either have a strictly 'typological' or a strictly 'technological' meaning; 'discoid' is typically decapitalised in the first case and capitalised in the second case ('Discoid') to signify this important difference (Boëda 1995a). Discoid cores in the 'Bordian' sense are morphologically defined, as cores that have a 'discoidal' shape. As such, they do not always attest to the presence of the 'Discoid' method. The occurrence of 'Discoid' cores can only be evidenced by demonstrating the presence of a 'Discoid' technical system; 'Discoid' technology, as a consequence, is not reliably proxied by the mere presence of 'discoid' cores – especially if this presence has an anecdotal character – but requires scholars to convincingly show that 'discoid' cores are a systemic/regular feature of the assemblage and co-occur with the four main characteristic blank-types of 'Discoid' *débitage* systems (Boëda 1993, 1995a; Mourre 2003; Deschamps 2017: 35).[620] It is in this sense that 'discoid' cores can be said to designate polyvalent words, whereas 'Discoid' cores bespeak of the language of 'Discoid' technology.[621]

A second example is provided by the polyvalent category of 'Levallois points.' Boëda (2013) and others have suggested that, in order to do justice to important differences in their technological signification, one must at least distinguish between two types of 'Levallois points.' The former (*ibid.*: 132-138) generally discriminates between *« typo-pointes Levallois »* ('Levallois type-points') and *« pseudo-typo-pointes Levallois »* ('Levallois pseudo-type-points'). These types are interpreted to reflect 'two intentions tied to different production objectives' (*ibid.*: 132). 'Levallois type-points' are typically produced from properly installed Levallois cores (i.e., two asymmetric hemispheres, etc.) and tend to occupy the distal part of a preferential Levallois blank-production series. 'Levallois pseudo-type-points,' by contrast, can be manufactured from different production systems and typically derive from the outermost perimeter of two-hemispheric core architectures via 'recurrent' (non-hierarchical) reduction modalities (cf. Slimak 2003: 58f.). They are typically a product of 'Discoid' (Discoid *sensu stricto*) and 'Discoid-like' (Discoid *sensu lato*) technologies (cf. Deschamps 2014: Fig. 125).[622] Quite often, this technological difference is reflected in blank-axialities (axis of detachment) and the type and degree of proximal investment/preparation. The signification of these differing qualities, however, can only be recognised if the 'technical logic' of the lithic technologies that host them is compared.[623] The distinction conjures a contextualistic logic.

As a third example, it is instructive to examine the contested category of burins. Burins have been interpreted as either tools or bladelet-cores – they represent a lithic category where typology-technology relations are constantly re-negotiated (e.g., Perlès 1977, 1982; Ducasse and Langlais 2008; Chehmana 2009). The burin discourse in the French scene clearly shows that burin 'types' are not semantic categories *per se* – but, typically for contextualism, their potential status as semantic categories is also not categorically denied. The implication is that the signification of various burin 'types' must be demonstrated empirically rather than categorically predicated. Generally, burins are thus not understood as a homogenous technological category. Although all burins of course share some overarching features, different burin-types may have served distinct functional and/or technological needs. According to most researchers, the only way to determine their status is to analyse how different burin types *interact* with the assemblage-totality (cf. Le Brun-Ricalens and Brou 2003; Pesesse and Michel 2006; Le Brun-Ricalens et al. 2006; Chehmana et al. 2007; **Fig. 44**). Burins, in other words, must always be contextualised with other artefacts of their assemblage-context in order to decide whether they served primarily as tools or as core-matrices (cf. Pesesse 2002). It follows that the interpretation

---

[620] The disagreement between Tostevin (2000, 2012) and Boëda (1991, 1993, 1995a, 1995b) on the interpretation of 'Discoid'/'discoid' technology in the Micoquian of Kulna cave can be reconstructed by reference to this difference. Tostevin (2012) constantly refers to 'discoidal shape' in his analysis while shape is not at all the main concern in the technological definition provided by Boëda (1995a). We may say that Tostevin speaks about 'discoid' while Boëda implies 'Discoid.'

[621] See also Bourguignon and Turq (2003) for an exemplary case of analysing the interplay between tool typology and Discoid technology.

[622] For a discussion of the difference between 'Discoid' technology *sensu lato* and 'Discoid' technology *sensu stricto*, see e.g., Mourre (2003: 9-11) and Deschamps (2014: 86, Fig. 30).

[623] The typological category of 'Levallois' (*sensu* Bordes 1961a/b) is generally approached with a certain dose of caution; for example, 'Levallois blades' may have a different 'technological' signification depending on whether they occur in 'recurrent' Levallois systems with a laminar tendency or in 'non-Levallois' systems of laminar production (cf. Révillion 1993). A detailed analysis of the relationship between the 'typology' and 'technology' of Levallois blades based on technological refits of the Middle Palaeolithic assemblages of Seclin and Saint-Germain-des-Vaux is provided by Révillion (1994).

of burin typology critically depends on technological organisation – the 'function' (fonction) of a burin-type thus corresponds to its relative place within the 'structure' (*structure*) and 'operation' (*fonctionnement*) of its technical context.[624] A burin-type is simply conceived of as a node within a wider technical 'infrastructure.'

The burin discussion shows that types are rarely 'reified' or 'essentialised' and must always prove their epistemic utility;[625] types are primarily methodological operators that help to dismantle technical 'textures' and to reach out to technical 'qualities.' Types are not innocent, but highly mutable to this effect. The goal of technological analysis is generally to find those types that help to surmount the encountered interpretive obstacles – that is, to identify ways of typologisation which illuminate as *many other co-present lithic artefacts as possible*. To show that a burin-type signifies, *pars pro toto*, bladelet-production rather than tool-use, one would therefore need to show that the respective type helps to understand the presence of other lithic types in the same technical context – for example, that presumably bladelet-producing burins are associated with fitting bladelets (i.e., bladelets of a matching morpho-technical character) and the respective by-products (i.e., matching preparatory elements)[626] and that all of them, including the burins themselves, are non-anecdotal elements of their context (cf. Ploux and Soriano 2003: esp. Fig. 6).[627] It must be said, however, that even the non-satisfaction of one of these preconditions may not be enough to reject the core-hypothesis since scholars may be capable to providing a satisfactory contextual explanation for this non-satisfaction (e.g., Faivre 2012).[628]

All of this demonstrates that a lithic 'morpho-type' is not automatically co-extensive with a lithic 'techno-type.' Typology is a relational practice and cannot be successful if attributes and 'traits' of artefacts are cut-off from their contexts and marshalled exclusively 'bottom-up' – 'technological typologies,' the primary target of French typologisation, hence generally enshrine *situated* categories. This only confirms that the role of typology in French lithic research is to support contextualistic analysis and is often contextualistic itself.

The interpretive primacy of technical contexts also permeates more recent work on lithic technology in France. Scholars now often devise morphometric sub-types – for example within the category of laminar blanks – in order to relate these types to different 'micro-contexts' of technical systems (e.g., Langlais 2010: Figure 141, 145; Mevel 2017: Figure 116, 155). In other words: they assess the morphometric space of exploitable blanks based on the types of core-matrices encountered in an assemblage and use these expectations to explore the structure of metric data within the same category of blanks. The morphometric sub-types are thus dependent of knowledge on the nature of *morphometric constraints* imposed by a particular type of core-reduction system (e.g., Pigeot 1991: Fig. 4).[629] It should be noted that these authors tend to speak of 'classes' rather than types, a habit that probably reflects the sedimented belief that types carve out reality in a more conclusive manner than classes do.[630] The point, however, is that both 'typologisation' and 'classification' are highly dynamic practices

[624] This implies that typology is often not an independent operation in French lithic analysis but fundamentally depends on technological inquiry and its fruits of knowledge; this situation marks a signature difference to 'formism' where typology typically constitutes an *independent* operation.
[625] *Contra* Tostevin (2011b: 359), Shott (2003: 100, 2010), and Shea (2013a: 154, 2014, 2017a).
[626] To show that the present bladelets or a sub-set of them is most parsimoniously explained by the presence of certain burins typically involves a negative argument about other potential sources of bladelet-production. This argument is relational since it situates burins relative to other potential and actual core-matrices. Where a particular blank-group originates from is therefore always a *relative* question.
[627] A typical 'mechanistic' objection is that the status of burins can only be determined by conducting use-wear analysis, echoing the 'mechanistic' intuition that similar types often result from different causal processes. This critique, however, misses the mark because the kinds of types devised and criticised in 'contextualism' have been constructed and secured contextually. Their 'truth' is evaluated from *within* and therefore does not depend on external validation. The burin-core debate that has been waging for years in Palaeolithic archaeology is thus nothing more than a symptom of the ongoing clash between 'mechanistic' and 'contextualistic' modes of reasoning.
[628] The ability to explain why something is significant even though it is not frequently or systematically present in a lithic assemblage is a 'trademark' of 'contextualistic' modes of inquiry; it reflects the 'contextualistic' credo that nothing can be denied and nothing can be presupposed other than that nothing is presupposable (see Chapter 2).
[629] Valentin (1995: 27) explicitly notes: "[t]his approach demands a faithful reconstruction of the objectives assigned to the *chaîne opératoire* as well as a detailed appreciation of the circumstances of its realisation ("*the space of the possible*"). When these circumstances are properly appreciated [and understood], the prehistorian is able to evaluate whether this or that modality is the necessary answer in a given situation (when "the possible space is closed" [Pelegrin 1995]) or if it is merely one of the anticipated solutions from a set of possible options. This is a difficult assessment, which necessarily requires a global understanding of the *chaîne opératoire* [....]." (my translation; original italics [for the original French quote, see **Appendix Q.14**]).
[630] But compare the discussion of the relationship between typology and classification offered by Perlès (1988: 1080): "[i]n any archaeological ensemble, there are pieces (combinations of attributes) or attributes (manufacturing techniques, shapes, raw

and necessarily anchored in co-constitutive technical relations. Their orientation is blazingly contextualistic in Pepper's sense.

5.2 **Tropes of organicism in French practice**

5.2.1 ***Boëda's notion of « Levallois récurrente »***

Éric Boëda's work on the various methods and modalities of Levallois technology probably represents the most organicistic strategy in the French scene to understand lithic technology on the assemblage-level.[631] This approach is laid out comprehensively in Boëda's (1986) influential doctoral dissertation, later published as a monograph under the title *Le Concept Levallois: variabilité des méthodes* (1994). Several other key papers about the same topic were published between these two landmarks, all of which explore the tension between the 'unity' and 'internal variability' of Levallois technology (e.g., Boëda 1988, 1990, 1991, 1993); they embody an approach that systematically distinguishes between 'technique,' 'method' and 'conception' in order to illuminate Levallois diversity (Boëda 1988: 185).[632] Conceptually, the approach treats 'diversity' as the flipside of 'unity' – an interpretive preoccupation characteristic for organicism.[633] Higher-level unity is thought to condition lower-level diversity – the two are viewed as being mutually dependent.[634] Accordingly, Levallois 'modalities' are defined as lower-level technical variations, not violating the principles (and general technical rules) of a given Levallois 'method.' All of the different levels of variability are specified in 'volumetric' terms (Boëda 1994).

This meticulous analysis of the 'Levallois phenomenon' culminates in the seminal portrayal of Levallois as a 'facial' or 'surface-extracting' technology – a kind of technology that is regarded to be fundamentally opposed to 'volume-extracting' technologies (cf. Boëda 1990, 1988: Figs. 18.9-18.10).[635] According to Boëda (*idem*), the difference between these two types is rooted in their technical 'structure.' As it will become clear from the following exposition of Boëda's characterisation of 'recurrent' Levallois systems based on the lithic material from Biache Saint-Vaast, presented in detail in *Analyse technologique du débitage du niveau IIA* (1988), 'structure' has not the same implications here as in 'contextualism.' Instead, 'structure' is interpreted in organicistic terms, as 'organic structure' achieved through a specific 'organic process' that can be defined by its 'progressive' and 'ideal' categories.[636]

Boëda's approach to Levallois technology and the identification of 'recurrent' methods in particular is guided by two key assertions: (i) each Levallois 'method' is conceptually discrete (i.e., bespeaks of a distinct *schéma opératoire*); and (ii) each 'method' is characterised by a specific spatio-temporal organisation of its corresponding *chaînes opératoires* (i.e., it makes room for a *chaîne directeur*). Although his approach is generally based on a classic 'technological reading' (*lecture*) of the assemblage-totality, including the detailed examination of *schémas diacritiques*, and the 'virtual' reconstruction of technical artefact-interrelationships ('mental refitting') (Boëda 1988: 186; see previous part of the chapter), the way in which these two assertions are defended suggests that the analysis is governed by an organicistic logic.

---

materials, etc.) considered characteristic of the whole [...]. It is for clearly pointing out differences (or similarities) that the prehistorian elaborates a typology, or utilises an already existing typology. When developing a typology, based on groups of pieces (complex combinations of attributes), one necessarily performs a hierarchisation of features [...]. A typology is therefore very different from a classification since each piece could, strictly speaking, belong to several types [...]. But it is characteristic of a typology to bring to light those features which make it possible to solve specific archaeological problems [...]. In principle, a typology should be designed relative to the problem posed (which dictates the choice of relevant characteristics), and several typologies can be applied to the same whole to solve different problems. [...] Whatever may be our interest, a classification will always express a real structure within the studied material since it is based on its intrinsic properties. This is one of the differences with a typology where one instead chooses to privilege certain features, and to rank them according to the problem posed." (my translation [the original French quote is provided in **Appendix Q.15**]; cf. Valentin 1995: 2, footnote 2)

[631] As we will see in this part of the chapter, 'organicistic' reasoning turns out to be correlated with a specific temporal perspectives, it typically operates on higher-levels of analysis (see *infra*).

[632] For a good summary of this approach, see Chevrier (2012: 139-141).

[633] 'Unity' is interpreted as 'integrity' – specifying the *external* relatedness of the Levallois phenomenon – and 'diversity' is simply interpreted as the 'structure' of the integrated whole – specifying the *internal* relatedness of the whole's parts. This conception is, first, 'synthetic' since it concerns the question of how parts are bound together by significant wholes and, secondly, 'organicistic' since the identification/determination of 'significant' wholes is part of the basic epistemic task the analyst has to complete (cf. Chapter 2).

[634] We will return to this 'organicistic' key *topos* at a later stage in this chapter.

[635] These 'volume-extracting' technologies are typical for the Western European Upper Palaeoltihic, where they find their climax in developed prismatic blade technologies (Boëda 1990, 1994).

[636] See Chapter 2, and esp. Chapter 2: **Box 9**.

An organicistic orientation is already indicated by the strong emphasis on the idea of the 'operational scheme' (*schéma opératoire*) and the outlined temporal structure of 'recurrent' Levallois technologies.[637] The notion of the 'operational scheme' not only entails an emergent conception of technology – technical systems are viewed as 'more-than-compositional' (Boëda 1988: 185) – but also embodies an 'ideal' category itself, somewhat detached from the 'progressive' categories detectable via the 'stigmas' preserved on the given lithic artefacts (cf. *ibid.*: 185f.).[638] The 'progressive' categories, those that delineate the space of description and thus a 'significant' whole, are found in the spatiotemporal structure of Levallois reduction. In particular, the strategy is to find a 'structure' that is capable to integrate the 'progressive' categories, clearing the view for the 'ideal' whole. Even though both spatial (i.e., volumetric, geographic/topological) and temporal dimensions of technological organisation are considered, the crucial point is that it is primarily the temporal 'structure' of reduction which gives meaning to the observed spatial articulations of lithic artefacts and artefact-groups. Temporality is thus conceived as a *superordinate* category[639] – a presupposition that is germane to organicistic modes of reasoning (cf. Pepper 1942: 308-310).

The organicistic logic of Boëda's technological reconstruction becomes especially evident when we retrace the spatiotemporal structure of 'recurrent' Levallois and examine how this 'structure' is empirically established. The first aspect to note is that the 'recurrent' method of Levallois – subdividable into two modalities (uni- and bidirectional) – is characterised by a specific order of well-separated technical 'stages,' each of which is defined by a specific articulation of artefacts and technical gestures/operations (**Fig. 45**). Each 'stage,' in other words, forms a sub-set of the material and non-material ingredients that together form the technical system we call 'recurrent' Levallois – these 'stages' are part of the 'progressive' categories of the latter. This general character of reconstructing technology reveals that the 'synthetic' constitution of a technical whole (part-whole interweaving) is interpreted *temporally*, which, in turn, illustrates that the variability and heterogeneity of a lithic assemblage is primarily resolved by shedding light on the integration of the assemblage-parts (primarily lithic artefacts) by a temporally extended process of volumetric reduction of high technical specificity. This process is shown to make sense, that is, to *resolve* the initially observed heterogeneity. It is in this sense that we can speak of an 'organic process' which is initially 'concealed.'

It is 'concealed' because the process is not immediately given or obvious in 'phenomenal' reality – that is, the 'reality' of physically scattered artefacts; it only becomes apparent through a careful re-organisation of the lithic 'fragments' into qualitative units of time (i.e., reduction stages), so that the process of passing through the latter in the correct direction can be shown to *integrate*, that is, 'unify', all initial fragments in a single 'organic whole.'[640] The system Boëda calls Levallois 'recurrent' is nothing less than such a unified 'organic whole,' which accordingly comes into view only through an under-

[637] 'Scheme' is not an innocent concept. *Schéma* is for example a key term in Piaget's theory of developmental psychology and there are obvious conceptual affinities between the former and the notion of the 'operational scheme' (*schéma opératoire*) in French lithic analysis (cf. Schlanger 1994). A 'schema,' for Piaget, is a cluster of concepts used to represent the world, i.e., objects, scenarios, sequences of events, or relations. Piaget (1952, 1964 [1959]) famously distinguished between *behavioural* schemata (organised patterns of behaviour guiding the representation and manipulation of objects and experience), *symbolic* schemata (internal mental images and/or other systems of codification to represent and organise experience), and *operational* schemata (internalised mental patterns to deal with an operationalise problems). All of these strands are somewhat relevant for the reconstruction and interpretation of technological *schémas opératoires*. The concept gives voice to the idea that practice, representation, and cognition are deeply enmeshed in human technicity (cf. Pigeot 2011; see Boëda 1997: 12 for an explicit citation of Piaget's work). The important point is that Piaget's *developmental* theory is 'organicistic' in many regards – a circumstance that is perhaps best reflected in the fact that the 'becoming' of the human individual (its 'genesis') is thought to be achieved through a succession of distinct developmental 'stages.'

[638] The term 'stigma,' regularly used by Boëda himself, has – as already outlined in Chapter 3 – relationalistic implications. In addition, however, it signals the 'fragmentariness' of artefactual information insofar as lithic artefacts convey merely *traces* of the technical systems in which they originally participated. In the context of Boëda's (1988) reconstruction of the 'recurrent' Levallois method, this can be taken as preliminary indication that artefacts are primarily understood as 'fragments of experience' – thereby confirming the 'organicistic' orientation of his approach.

[639] Time, in other words, is considered to be the supreme/superior 'structure-giving' force in nature.

[640] The centrality of a technical system's temporal 'structure' – what in 'contextualism' would be referred to as the temporal 'spread' of a technical 'texture' – makes it necessary to invoke qualitatively discrete elements that enable the analysis of a technical whole's unfolding in time; one can therefore not content that the introduction of 'reduction stages' is a deliberate interpretive decision here, fully under control of the analyst. Rather, we have to acknowledge that the introduction of 'stages' or 'steps' is *required* to render the offered account conceptually consequential as well as consistent. The resulting 'staging' of the lithic technological architecture can therefore not rejected by simply appealing to some selected facts; its rejection necessitates the rejection of 'organicism' altogether. The controversy between advocates of 'discrete' and 'continuous' reduction in lithic studies (see e.g., Baumler 1987, 1988; Baumler and Speth 1993; Dibble 1995a; Henry 1995; Shott 2010, 2017; and Shott et al. 2011 for a general defence of 'continuous' reduction scenarios) is thus likely to be the symptom of a more basic clash between 'organicists' and 'non-organicists' (especially 'formists' and 'mechanists'). We will return to this point in Chapter 6.

standing of the underlying 'organic process' that determines its coherence and 'technical reality' (*réalité technique*). This 'organic process' exhibits subtle but significant differences when we compare 'uni-' and 'bidirectional' systems of 'recurrent' Levallois technology. Importantly, the emerging gap between *Appearance and Reality* is distinctive to organicism.

The basic strategy is to order the assemblage into 'significant' technical 'structures' and 'sub-structures' and to show that all initially encountered 'fragments of experience' – lithic artefacts – can thereby be *resolved* into their respective technical wholes; the 'structures' and temporal 'sub-structures' constructed are shown to be 'significant' due to their ability to *enable* this process of resolving.[641] This is demonstrated by illustrating that only with the help of the respective 'sub-structures' it becomes possible to render their corresponding 'structures' temporally *coherent*.[642] The two following aspects are important to consider in this regard.

First, technical wholes ('technical systems') are conceptualised as 'determinative' forces, which is another way of saying that the taken approach is 'integrative;' it is 'integrative' because, on the assemblage-level, 'relevant' lithic artefact variability needs to be separated from 'irrelevant' variability – the specification of a 'significant' whole entails the definitive specification of artefacts belonging to the whole and artefacts not belonging to it. A single 'organic process' is then shown to explain why this must be the case; this process is 'directed' and 'teleological' insofar as it serves to satisfy one single 'ideal' – the *schéma opératoire*. The resulting explanation is 'economic' since it saves all initial 'fragments of reality' without any loss and thereby reveals their 'unification' through various temporally extended yet 'significant' wholes (*sensu* Pepper 1942: 306f.).[643] This also implies that all lithic artefacts allocated to a 'significant' organic whole are shown to *imply* the whole, whereas the whole can be considered to *transcend* its fragments – this is the delicate balance between 'implicitness' and 'transcendence' that is typical for organicistic inquiry (*ibid.*: 304f.).

Second, the general strategy of analysis clearly exposes that knowledge claims are secured by demonstrating that each identified technical 'structure' can be *coherently* described by bringing to bear its 'sub-structures' and a specific 'organic process' that authors and organises them (*sensu* Pepper 1942: 283).[644] The initially observed 'conflicts,' 'counteractions,' or 'contradictions' between the 'fragments of reality' (i.e., the lithic artefacts) are shown to dissipate in this way because the whole turns out to be *temporally coherent* with the totality of its parts, despite the material heterogeneity of the latter.[645] This is the classic interpretation of knowledge corroboration in organicism – it confirms the presence of a 'coherentist' account of cognitive 'veracity,' stressing internal technological intelligibility.[646]

Boëda (1988) accordingly seeks to *minimise* all inconsistencies, contradictions, and explanatory gaps on the assemblage-level, while at the same time maximising the cognitive economy of his account; epistemic virtues such as interpretive 'elegancy' and explanatory 'simplicity' are thus interpreted through the lens of organicism, as the ability to provide a 'progressive' technical process that is 'or-

[641] See the exposition of the proper 'organicistic' theory of cognitive criticism in Chapter 2.

[642] Boëda (1988) thereby acknowledges that lithic artefacts deposited together (lithic assemblages) do not necessarily belong together technologically. Thus, to identify those lithic objects which belong together and to separate them from all other objects emerges as a key task. In 'organicistic' terms, one can understand this as re-casting the lithic assemblage as a problematic whole, whose 'organicity' can only be verified by showing that all of its artefacts can be resolved in 'significant' sub-wholes (i.e., particular technical systems) without any loss. This is the 'organicistic' interpretation of the technical 'infrastructure' of a lithic assemblage. The same reasoning can also be used to evaluate whether or not assemblages are *technologically coherent* and hence whether or not they are likely to be mixed or not. This is why 'organicism' motivates an entirely different type of 'source criticism' than 'mechanistic' which typically relies on 'formation theory' – a type of 'source criticism' that favours an 'internalistic' perspective and may be built exclusively on technological data.

[643] Boëda (1988: 213) explicitly names 'conceptual unification' as a goal of his analysis.

[644] Already Cresswell (1976: 6), one of the founder figures of French *technologie culturelle*, has noted: "[t]echnical chaîne opératoires have two essential characteristics: *internal coherence* and an organic relationship with the social structure." (my translation; emphasis added [for the original French quote, see **Appendix Q.16**]; cf. Cresswell 1983). For the concept of 'technical coherence' (*cohérence technique*), see e.g. Nicoud (2011: 68).

[645] This is another way of saying that inconsistency and heterogeneity turn out to be rather 'illusionary' since they only persist if one approaches lithic technology as a 'static' and strictly 'synchronic' entity, *not* extended and somehow 'distributed' in time. A truly 'dynamic' account, by contrast, is capable – and 'organicism' interprets 'dynamism' primarily in temporal terms – to show that the respective heterogeneity vanishes if the temporal configuration of 'distributed-ness' and 'interconnectedness' are taken seriously into consideration. In Bergson's (1907, 1922) classic formulation, this trail of reasoning entailed a basic epistemological critique on human knowing, which was regarded to regularly fall prey to the phenomenological illusion that worldly objects are somehow 'static' and thus temporally fixable entities. It follows that the 'real' *temporal existence* of phenomena is generally difficult, if not impossible, to observe directly.

[646] See Chapter 2 and Pepper (1942: 308-314).

ganic' and realises its inherent 'ideal.'[647] It is no surprise then that Boëda's argumentation is multidirectional, often rather intricate, and generally 'dialectic' – the account is 'coordinative' to this effect (i.e., it coordinates all lithic 'fragments of reality'). However, it has to be noted that this 'complexity' is not so much a property of the offered explanation itself (which is in fact fairly 'simple'), but rather an essential characteristic of the nexus of argumentation and embedded interpretation that is required to develop, present, and secure it.

The effective *coordination* of all original lithic artefacts, interpreted as 'fragments of reality,' via the postulation of relevant technical 'structures' and their 'progressive' categories – lithic reduction 'stages' – is the organicistic corollary of the 'contextualistic' 4D-puzzle. But puzzle-solving is understood as a reversed, directed process of organic growth. Each 'stage' of reduction is a logical consequence of its preceding 'stage' and coevally determines the 'stage' that follows. We can say that each 'stage' implies its past and is 'pregnant of its future' – a credo highly characteristic of organicistic thought. In the case the lithic assemblage of Biache Saint-Vaast IIA, the coordinative maximisation of explanatory economy leads Boëda (1988: 186) to identify *multiple* technical wholes exhibiting patterns of inversed technical growth that are *specific* to them (reduction schemes 'A' to 'E'). The proposition that these technical wholes correspond to distinct 'concepts,' 'methods,' and/or knapping 'modalities' is hence a largely unavoidable result of the taken approach.[648] The 'discreteness' of the 'stages' themselves follows from the fact that their order is *not* arbitrary or interchangeable since each 'stage' has determinative significance – the totality of 'stages' is technically *enchained* (*enchaînement technique*) (cf. *ibid*.: 1987).[649]

The point is not that a fundamental re-organisation of lithic reduction – e.g., successively employing different knapping strategies to a single core – is generally impossible, but that the costs would be unreasonably high. This leads to the conclusion that economic knapping behaviour would typically consist in the avoidance of knapping-pattern alternations – an insight that, ironically, is often opposed by 'mechanists' by calling upon *Homo oeconomicus*.[650] The entire point of setting-up a specific volumetric core-architecture is to achieve its corresponding knapping 'ideal' through a specified set of 'progressive' operations; especially in the case of Levallois technology, where initial preparatory investment is generally high, it is therefore unlikely that the reduction strategy will experience major changes during core reduction.[651] In addition, if core re-organisation was a regular aspect of technological organisation at Biache, it can be expected to show itself after inter-artefact coherency is established.[652]

---

[647] Apart from the notion of the 'operational scheme' (*schéma opératoire*), another conceptual locus where the 'progressive' and 'ideal' categories meet is predicated by the idea of a 'knapping plan' (*projet de taille*) which is thought to connect the former with the latter (Boëda 1988: 185).

[648] This fact is probably responsible for the basic conflict between Boëda's (1988) and Dibble's (1995a) accounts of the lithic technology from Biache Saint-Vaast level IIA (see *infra;* cf. Chapters 1 and 3).

[649] 'Organic' lithic reduction leads to *technical entrapment*. It implies that specific lithic reduction trajectories open a space of technical options becoming more and more constrained as reduction proceeds, especially when initial technical investment was high (e.g., relatively cost-intensive early (preparatory) phases of a *chaîne opératoire*). Because of the specific technical consequences of each trajectory, only a number of knapping solutions lead to acceptable knapping results, others punish the knapper (e.g., by an increased risk of knapping errors, etc.) (cf. Pigeot 1991: Fig. 4). To change the logic inherent to a given reduction trajectory, for example foreshadowed by a specific core set-up, often requires to re-set the entire core- and reduction-architecture, a procedure that typically depends on renewed preparatory investment and is often non-economic (especially in terms of raw material consumption). Lithic reduction is *path-dependent* to this effect (cf. Boëda 188: 210). Boëda (1988: 210) himself maintains: "[…] [t]hey [the knappers of Biache Saint-Vaast level IIA] were, as it seems, prisoners of the limitations inherent to the volumetric conception of the Levallois core, which fixes a specific function for each of the two [reduction] surfaces." (*ibid*.: 191f. [for the original French quote, see **Appendix Q.17**]).

[650] It can in fact be concluded that the 'organicistic' interpretation of the *Homo oeconomicus* underlines that 'economic' reduction behaviour is only possible if the interlink between the 'progressive' and 'ideal' categories of different knapping concepts is respected; the 'economic' potential of a knapping concept lies precisely in its capacity to fulfil its 'ideal.' If the chain of 'progressive' categories is thus interrupted, a part of the knapping investment has been wasted – this can be viewed as 'un-economic.' The clash between 'mechanism' and 'organicism' consists thus in a fundamental disagreement on how to measure and objectify 'economic-ness' – the former typically assesses economy in terms of 'absolute' and 'external' categories, while the latter examines it in terms of 'relative' and 'internal' categories.

[651] There is of course still the possibility that reduction patterns change because of some *unforeseen events*. Such events may be unrepairable knapping accidents that destroy the required volumetric structure, so that lithic reduction cannot continue as anticipated, or the depletion of the raw material matrix of a core. In the latter case, it becomes opportune and hence economic to extract as much further material as possible, no matter how.

[652] If inter-artefact coherency can be established without postulating a change in core management, one has little reason to invoke such a change. Again, this logic reflects the 'organicistic' interpretation of the simplicity principle: *Okham's Razor* suggests to minimise the number of reduction strategies that feature in a given explanation (cf. Sober 1988, 2015). *Okham's Razor* is thereby interpreted 'synthetically' and thus diverges from the *Razor* that is typically invoked in 'formism' or 'mechanism.' In fact what 'simplicity' *means* is simply contested among these theories.

To illustrate the main points outlined so far, it is useful to examine Boëda's reconstruction of uni- and bidirectional *« Levallois récurrente »* in more detail, especially how distinct 'stages' of reduction are identified and characterised. In general, *three discrete stages of débitage* are pinpointed, all of which are defined by a specific articulation of groups of blanks and core configurations (Boëda 1988: 186-196). The basic strategy is to understand the *consequences* of particular flake removals for the configuration of the corresponding cores and, conversely, the *consequences* of particular core configurations for the structure of the corresponding flakes. The aim is to coordinate these consequences in such a way that extracted flakes explain particular core configurations and the core configurations explain particular flakes (e.g., *ibid.*: 198). Flakes and cores are considered to be potentially *complementary* 'micro-structures' which participate in effective 'meso-structures' (reduction 'stages') whose temporal enchainment gives birth to technological 'macro-structures' (technical systems) (*ibid.*: Fig. 18.7; **Appendix III.5: Fig III.6**). The structure-giving features are different in all of the three cases.

The relevant 'stigmas' on flakes are physical outline, spatiotemporal structure of dorsally preserved scars (i.e., scar-geography, scar-directionality, scar-chronology), angulations (i.e. profile, cross-section, dorsal convexities, etc.), and the direction of detachment (Boëda 1988: 187). Based on these and other features, it becomes possible, given one has formed a general understanding of the architecture of the cores from which these flakes most likely stem, to infer to effects of their removal on the convexity of the core-surface from which they have been extracted. These effects regulate future flake-removals, and so forth. Relevant core 'stigmas' are represented by the physical outlines of fully preserved flake-negatives, the spatiotemporal structure of flake-negatives on the reduction surface (i.e., scar-geography, scar-directionality, scar-chronology), and the general configuration of surface-convexities (*idem*). Based on these and other features, it is possible to retrodict how the preceding flake-removals must have looked like and to anticipate how the next removal(s) would look like (*ibid.*: 199-201) – the latter is basically a function of the nature of extraction-convexities on the core surface created through past removals (cf. *ibid.*: Fig. 18.2, 18.8-18.10).

The distinction between 'determining' flakes (*prédéterminé*) and 'determined' flakes (*prédéterminants*) (Boëda 1988: 185) is a direct consequence of this logic of reasoning and enshrines the methodological impetus to assess flakes in light of cores and cores in light of flakes (*ibid.*: 198; cf. Boëda 1986: 181-252).[653] Each artefact is viewed to conserve traces of past technical operations and to be pregnant with future operations (cf. Boëda 1982).

With Pepper we can make sense of this in the following way: each single lithic artefact is identified as a 'fragment' of its technical reality (*réalité technique*) with a specific 'nexus' of *technical potentiality*. This nexus is determined by a fragment's 'stigmas' (see *supra*) and delineates the possible technical connections that the fragment may have maintained with other lithic fragments. A technical 'nexus' thus constitutes a field of potential relations with other lithic artefacts. We can say, then, that Boëda compares the 'nexuses' of flakes with the 'nexuses' of cores in order to determine their meeting point(s).[654] These meeting points are ways in which the lithic 'fragments' may complete themselves (*sensu* Pepper 1942: 291f.), by merging together with other fragments to form a larger technical 'structure.'[655] If there are no plausible meeting points, the fragments can be said to be 'irrelevant' for each other's integration.

[653] Cf. "[…] The study of cores must have priority. The core is the most important vector of information to determine the utilised concept of knapping, especially because it bears the stigmas of the employed methods or techniques. The analysis of predetermined and predetermining flakes is secondary: it is from this study that the method or methods employed by the knapper will be definitively determined. This methodological articulation between nucleus and flakes must evidently take into account the informational capacities provided by the artefacts of an archaeological site." (Boëda 1988: 1985; my translation; for the original French quote, see **Appendix Q.17**). Even though Boëda insists on the analytical priority of cores here, this priority is essentially born out of interpretive convenience; cores and flakes are methodologically equals, but because cores typically preserve more information (each core usually corresponds to a number of flakes) they constrain the possible meeting points of 'nexuses' stronger than single flakes do. However, in order to know which cores belong together (i.e., form the fragments of a single reduction method/system), one already needs to have inspected all flakes in the same assemblage. The entry point of inquiry is thus generally arbitrary and a matter of convenience, rather than theory. This should not be surprising since argumentation and inference tend to be 'dialogical' and 'multi-directed' in 'organicism.'

[654] If there are multiple meeting points of the involved 'nexuses,' the criterion of total *coherency* decides which of the meeting points is most likely to be relevant in the current technical context. The question, then, is simply which of the meeting points positively articulates with the other so far determined meeting points of 'nexuses' in the organic whole. It is to this effect that the whole is of primordial importance in securing 'organicistic' knowledge.

[655] The 'nexus' of a fragment thereby simply drives home the 'organicist's' conception that the whole has always been *implicit* in its parts, but at the same time necessarily *transcends* it (see *supra*). Each lithic fragment is 'stigmatised' by its *chaîne opératoire* to this effect (cf. Pepper 1942: 304).

This conception clarifies how 'mental refitting' is interpreted in organicism: as *the coordination of 'nexuses' with the goal to integrate all lithic fragments in such a way that overall technical coherence is reached*.[656] 'Mental refitting' is thus simply the name for a procedure that seeks to determine the technical meeting points (if any) of various lithic artefacts sharing a 'significant' technical context (i.e., assemblage, technical system, etc.) (cf. Boëda 1988: 198). Accordingly, artefacts are complementary from a technical point of view when their 'nexuses' meet. This way of 'matching' lithic artefacts and to determine which belong together and which not is clearly reflected in Boëda's Fig. 18.16 and Fig. 18.17, in which particular articulations of Levallois core and flake structures (i.e., their mutual implicatedness) are theorised (**Appendix III.5: Fig. III.7, III.8**; cf. **Fig. 6A** in Chapter 3).

The identification of 'uni-' and 'bidirectional' reduction methods as distinct variants of 'recurrent' Levallois reflects this organicistic orientation. A key difference between the two is that the unidirectional 'method' requires constant monitoring and regular re-preparation of the distal core-convexities, which otherwise deplete as a function of the general organisation of lithic reduction; the bidirectional 'method,' by contrast, through the alternating removal of a series of flakes from opposing platforms introduces a self-preparatory procedure ('auto-preparation'), which ensures that distal core-convexities do not deplete as quickly. Alternating bidirectional exploitation of the core-surface convexities, in other words, provides a means to manage/control these convexities. This difference in core management has subtle but significant consequences for the nature of the corresponding flakes. The bidirectional, self-preparatory 'method' enables the extraction of slightly more elongated flakes (Boëda 1988: 201f.) because the guiding ridges of bidirectional reduction create a less-pronounced, that is, 'smoother' distal core-angulation which permits controlled 'feathering' (*ibid.*: 187).[657] In addition, bidirectional cores have two distal parts that both serve as striking platforms of their own – they are thus automatically monitored and prepared (*ibid.*: 201).[658]

This articulation of bidirectional core-reduction and elongated flakes is confirmed by the metric data. Levallois flakes with a bidirectional scar-pattern are generally more elongated than flakes with unidirectional scar-patterns. Importantly, metric differences between relevant flake-categories are interpreted as a consequence of distinct reduction methods (Boëda 1988*:* 202-207), and not the other way around; metric differences *within* these flake-categories, conversely, are regarded to reflect raw material size reduction generated by increasing reduction depth.[659]

Since the resulting account delivers a coherent picture of the two methods, each of which is characterised by three logically-dependent reduction 'stages' – the first stage is 'preparatory,' the second stage reflects 'primary production' of maximally-sized Levallois products, and the third stage represents 'final extraction' of size-reduced Levallois products before raw material exhaustion – Boëda concludes that there is no empirical reason to assume a mixture of Levallois reduction strategies –

---

[656] By coordinating flake and core 'nexuses,' it becomes not only possible to recognise their co-constitution, but also to determine a flake's precise *location of removal* as well as its *date of removal*, which in tandem allow an assessment of the flake's *temporal positioning* and *technical function* in their *chaîne opératoire*. It is along these lines that a distinction between 'preparatory' and 'non-preparatory' flakes can be made. In 'organicism,' *knapping intentions* are thus interpreted through the lens of 'nexuses' and their global structure.

[657] Bidirectional Levallois 'recurrent,' however, also has some technical disadvantages. According to Boëda's (1988: 191) reconstruction, when core size diminishes this method (*Schéma B*) is much more likely to yield extremely flat extraction-surfaces – the central surface convexities of the 'active' core hemisphere are more likely to exhaust at the end of a core's biography. This explains why *Schéma B* cores are sometimes exploited along their lateral edges at the end of their use-life, generating strongly oblique detachments (*ibid.*: Fig. 18.8). What is thematised here again is the double-edged nature of technical systems: techno-economic effectiveness (*efficacité*) may be counterbalanced by technical entrapment; technology is 'boon' and 'bane' at once. We will come back to this figure of thought at the end of this chapter.

[658] Another consequence is a structural *asymmetry* between aligned and opposed scars on the dorsal face of bidirectional Levallois flakes (Boëda 1988: 201).

[659] The fact that 'size' is interpreted as a consequence of reduction method and the corresponding articulation of lithic fragments constitutes the primary reason why Dibble (1995a) and Boëda (1988) come to contradictory conclusions about Biache Saint-Vaast level IIA. For Dibble (1995a), 'size' is a parameter fixed to dimensional time, which means that reduction depth can directly be proxied with its help – 'size,' in other words, is interpreted through the lens of the 'field of locations,' a structural category proper to 'mechanism.' For Boëda (1988), however, 'size' is a *technology-mediated* parameter of lithic artefacts and thus contributes to an artefact's 'nexus,' just like any other artefact-feature. The main point for Boëda is that 'size' is a highly polysemic category since it may not only be shaped by the relative positioning of an artefact in its corresponding *chaîne opératoire*, but may also be determined by the artefact's location of detachment (e.g., products of initial centripetal preparation may be smaller than 'primary products' even though the former precede the latter in the operational sequence). From Boëda's perspective, a central weakness of Dibble's account is therefore that this possibility is not accounted for, that is, it is not explicitly tested as a competing hypothesis [it has to be emphasised here that the hypothesis of 'size' being a product of a lithic artefact's origin from the corresponding surface of reduction does itself not depend on a particular world theory chosen; each world theory must be able to somehow examine it].

each 'method' yields a specific set of 'progressive' categories furnishing a unique body of differentiated Levallois products. Lithic reduction is 'recurrent' because the second and the third 'stage,' *grosso modo*, generate a large number of non-hierarchised Levallois-products (all of the flakes are 'determining' (*prédéterminé*) and 'determined' (*prédéterminants*) at the same time) (Boëda 1988: 202). Levallois 'recurrent' differs in this regard from other Levallois 'methods' (cf. Boëda 1991, 1994).

It can be concluded that time acts as the primary *integrator* and its 'structuring' effects (i.e., the 'developmental stages' of lithic technology) help to organise the lithic facts; the analysis of Boëda's pattern of reasoning has shown that as soon as the 'correct' temporal structure of the targeted *chaîne opératoire* has been identified, the lithic facts, so to speak, "organise themselves" (*sensu* Pepper 1942: 291). The main strategy to secure corroborative truth is to ensure the coherence of assertive statements as they pertain to a technical process defined by its duration (*durée*). The handling of a core-matrix is pictured as an 'organic' yet determinative process which, once established, appears to be largely irreversible and path-dependent. Lithic technology is thereby defined by the 'progressive' categories it enacts; these, in turn, are specified by the 'ideal' categories to which they trend (i.e., the chain of 'reduction stages' serves the 'knapping project' and thereby fulfils the *schéma opératoire*). All of this leads to the conception that the 'temporal structure' of lithic technology is *technology-specific*; technological time itself is regarded to be 'qualitative.' It follows that different technical phenomena may navigate through time in a different manner and possibly at different speeds.[660]

Having said this, the key preoccupation of Boëda's account is the problematic status of excavated artefactual realities (i.e., the scatteredness of lithic assemblages). The 'essence' of lithic technology is not directly given and even regarded to be 'obscured' in this format of experience; human experience is viewed to merely grasp the fragments of lithic technology and these fragments themselves – the lithic artefacts – can thus not be trusted for they 'conceal' the true unity of 'organic' technical processes that propel lithic technology. This account is thus clearly organicistic on all levels of inquiry.

5.2.2 *« Paléohistoire », multiple temporalities, and the conflict of becoming*

« Paléohistoire » provides another glimpse into persisting tropes of organicistic thought in the French scene (cf. e.g., Audouze and Valentin 2010).[661] *« Paléohistoire »* is the attempt to connect different temporal scales – 'nano-' or 'micro-historical' (i.e., short-time occupations, knapping events), 'meso-historical' (i.e., social structures, sociotechnical norms and values), and 'macro-' or 'hyper-historical' ('civilisations,' periods, epochs) (*sensu* Valentin 2015) – in order to provide an integrated picture of long-term societal evolution (e.g., Pigeot 2004; Valentin 2005, 2008a, 2015; Bon 2009, 2010).[662] The

[660] The conceptualisation of time is of the essence and distinguishes 'organicism' from its 'integrative' sister 'mechanism.' If different technical phenomena travel through time in a different way, this implies that *time affects different technical phenomena differently*. Therefore, *technological time* cannot be measured by 'fixed' or *a priori* variables. In different technical systems, different variables may in fact turn out to be temporally sensitive (i.e., 'time-indicative') – the identification of 'temporal variables' is thus part of the empirical work that an 'organicist' has to do. This is exactly where Boëda (1988) and Dibble (1995a) disagree. Dibble's critique of Boëda's interpretation of the Biache Saint-Vaast IIA assemblage is based on an 'objectivist' account of time, according to which the relative chronology of reduction can securely be estimated by a fixed set of variables – a view that Boëda would clearly reject. For Boëda, time is to be measured differently when different 'organic' processes are at work.

[661] *« Paléohistoire »* is the name of a recently established umbrella-approach representing the crystallisation of various strands of theorising in the French scene since the late 1990s. It hosts two or three major branches of inquiry: first, what can be called *« Paléohistoire » sensu stricto* – based on the pioneering work of Jean-Pierre Fagnard (1988), Nicole Pigeot (2004), and Boris Valentin (2005, 2008a, 2015) – and, secondly, what may be termed *« Paléotechnologie »* in the wake of Éric Boëda (1991, 2005, 2013) and others (see **Appendix III.4** for more details). While the latter will be portrayed in the next section, the former can be subdivided into two sub-strands of inquiry. The first, building on the work of the 'Late' Leroi-Gourhan (1972, 1983a, 1984), Beatrice Schmider (1971, 1982, 1988; cf. Schmider and Roblin-Jouve 2008), Catherine Farizy (1990), Jean-Pierre Fagnard (1984, 1988) and others, foregrounds the sociological dimension of long-term population histories (see esp. Leroi-Gourhan et al. 1976); this approach, recently further elaborated by the work of Boris Valentin (2008a, 2015) and François Bon (2009, 2015), stands on the shoulders of French *« Sociologie préhistorique »*. The second sub-strand, mainly represented by the work of Grégor Marchand (2014, 2015), foregrounds dynamic human-environment interactions in writing the long-term history of past societies.

[662] The overarching ambition is to consolidate divergent strands of French 'palethnological' thought (cf. Valentin 2008a: 27, 33f., 2015). Valentin (2008a: 28-32) re-casts this problem as an issue of divergent time scales and their specific temporality of observation. He argues that Leroi-Gourhan's original *« Palethnologie »* carves out reality on a broadly 'microhistorical' scale – the relevant rhythms are tangible, they are often bodily and unfold in seconds, hours, and maybe days (lithic knapping, making fire, inhabiting a camp, etc.); *« Paléohistoire »*, by contrast, carves out reality on a 'macrohistorical' scale – its millennium-scale rhythms are less tangible and their significance is thus different. The dialectical movement between the 'micro' and the 'macro' and how they are temporally imbricated and/or enfolded into one another that is of primary interest for 'palaeo-historians.' The theoretical corpus on which this conception draws – sometimes consciously, sometimes unconsciously – is vast and includes

key concern is to understand the *interconnectedness* of the various scales of observation which are available to prehistorians – all of these scales are regarded to bear a distinct *temporal significance* (Olive 2005; Olive and Pigeot 2006; Bodu et al. 2006: 723f.; Valentin 2008a: 18, 21; Audouze 2010). The target of such research are the specific 'historical trajectories' of past societies, thought to signify the *genesis* or 'becoming' of societies in the *longue durée* (Bon 2009, 2015; Valentin 2011). Inquiry thereby focuses on how the targeted societies navigate the depths of time and how they handle duration (*durée*) (Valentin 2008a: 21; Perlès 1998, 2013).

Typically, research under the umbrella of *« Paléohistoire »* pays special attention to the 'dialectics' between continuity and discontinuity in the palaeo-archaeological records (e.g., Fagnard 1988: 125; Coudret and Fagnard 1997; Bodu and Valentin 1997; Valentin 2006; Jaubert et al. 2014).[663] Continuity and change are regarded to be a function of different, at times counteracting temporalities and their interrelationships.[664] Social evolution is conceptualised as a 'concealed' yet organic process, which in its temporal progression resolves any remaining 'conflicts' among its parts to come into view as an integrated whole. This reading of the evidence can build on traditional subdivisions of Palaeolithic periods such as the Magdalenian comprising 'Lower,' 'Middle,' and 'Upper' phases, re-casting these phases as 'stages' of organic social evolution (e.g., Valentin 2008, Langlais 2010).[665] *« Paléohistoire »* generally foregrounds the 'active' making of society as an interdependent and temporally 'structured' process.[666] The approach is tied to a basic reconsideration of the nature of time and bound to an ongoing, although often tacit, re-definition of Palaeolithic archaeology itself – as a discipline that offers a unique perspective on processes of the distant past that *take time* (cf. Perlès 1998: 17; **Fig. 46**). With Bergson – and following this line of reasoning further – one can maintain that no other discipline has direct access to this *duration* (*durée*) of human social evolution.[667]

The organicistic conception of 'stage'-mediated, path-dependent evolution, already encountered in the previous section, is directly reflected in one of the key tenets of *« Paléohistoire »*: the 'branching/dendritic paradigm' (*« paradigme buissonnant »*) (Valentin 2015: 183, 2011: 108).[668] This 'paradigm' stresses the contingent nature of societal trajectories, that is, that there exists a *plurality* of pathways even though social evolution is directed and largely irreversible. Each societal whole – although coming into view only in its duration – is defined by a specific exchange between culture and nature – or between 'man and matter' (*sensu* Mauss 2006 [1929/1930]; Leroi-Gourhan 1936a) – and hence by both its natural habitat and a set of traditions, technical norms, and values proper to it. A societal whole, accordingly, is characterised by its particular geographic place and its inner sociotech-

thinkers such as Fernand Braudel, Henri Bergson, Gaston Bachelard, Marc Bloch, Carlo Ginzburg, François Furet, and Claude Lévi-Straus – to name but a few.

663 Langlais (2010: 271), for example, explicitly speaks of 'dialectic' relationships in order to explain social evolution in the Magdalenian.

664 Continuity and change are understood as the result of 'thesis-antithesis' configurations that may or may not bring forth a new 'synthesis.' The key point is that this 'synthesis' can never be guaranteed – a circumstance that gives voice to organicism's 'progressive' structural categories of 'conflict' and 'contradiction' (*sensu* Pepper 1942: 292-297).

665 The ambition of *« Paléohistoire »*, following Boris Valentin (2006, 2008a: 30, 2015: 180), is to give meaning to the succession of these phases, i.e., to imbue them with a 'palaeo-historical' *sense* (*« sens »*) (cf. Bon 2009: 25). Valentin's (2011: 121, 2015: 182) vision of *« Hyperhistoire »* ('hyper-history') and the associated insistence to move beyond 'chronometric' practice and the tendency to write mere "compilatory histories" (Valentin 2008a: 30) reflect this emerging attitude. Establishing a 'palaeo-historical' *sense* ultimately means to identify the 'progressive' categories of a sociohistorical whole and to analyse their contribution to the fulfilment of the whole's 'ideal' categories. *« Paléohistoire »* is 'genetic' in this sense – it consists of 'putting chronology into perspective' (*ibid.*: 28-34). This 'palaeo-historical' ambition draws explicitly on the work of François Furet (1975), who sought to overcome purely descriptive history-making and to bring what he called 'problem-history' to the forefront of inquiry (cf. Audouze and Valentin 2010: 35). *« Paléohistoire » sensu stricto* – in the wake of Valentin and others – therefore seeks continuity with French *structural history*. A key point is that this orientation reinforces the general 'interpretive' stance (in the sense of *Verstehen*) of French Palaeolithic archaeology.

666 This 'structural' preoccupation of *« Paléohistoire »* is already anticipated by Valentin (2015: 177f.) who speaks of *« Ethnographie structurale »* ('structural ethnography') in order to characterise the 'palaeo-historical' endeavour of tying up divergent temporalities of observation.

667 According to Bergson (1907, 1922), only *duration* enables a realistic, 'dynamic' account of existence and may thus counterbalance the overly 'static' and 'presentist' representations of the world to which human minds are drawn. When French prehistorians speak of their ambition to develop a 'dynamic' account of human social evolution, they typically draw on this general conception (a conception not only held by Bergson of course).

668 The *« paradigme buissonnant »* may be interpreted as a subtle re-surfacing of the Bordian 'phyla model' of lithic industrial evolution (Bordes 1961c, 1963, 1968). However, Bordes framed his 'dendritic' conception of lithic evolution in broadly phylogenetic terms, while Valentin's concept is defined in strictly historical and, if you will, broadly 'epi-phylogenetic' terms (cf. Valentin 2011: 108). In addition, the former is based on lithic techno-typology whereas the latter is firmly anchored in the 'technological approach.' Nonetheless, the usage of a similar terminology may signal that the 'diachronic turn' tied to *« Paléohistoire »* entails a forceful return to the 'big narratives' of the founding-figures of French prehistory including the Bordes.

nical constitution. These two poles are thought to 'resonate' with one another, unleashing the historical dynamics that inaugurate distinct evolutionary trajectories.[669]

This conception relocates 'particularism' from spatiotemporal contexts to entire historical pathways (e.g., Valentin 2011: 122; Marchand 2014: 427).[670] But the idea is *not* that these pathways are strongly predetermined. The determinative significance of 'phases' and 'stages' can only be *diagnosed* (and thus 'retrodicted'), but can never exactly be predicted.[671] The reason is that the whole exercises determinative primacy, not its parts, which means that the parts alone cannot tell us which role they play in the whole. 'Organic' evolution is viewed as a long-term management of contingency that in retrospect *makes sense*. This directly reflects how organicism interprets 'integrativity' – as the *universality of developmental patterns realised in a multitude of different ways*.[672] Therefore, the developmental patterns themselves may be anticipated, but not what creates them. This is precisely what is implicated by Valentin's notion of the *« paradigme buissonnant »*. It corresponds to a concept of evolutionary determination that is fundamentally opposed to 'mechanistic' readings where the cause-and-effect chain generally proceeds in *upward* direction ('bottom-up').[673]

Valentin's *« paradigme buissonnant »* ('branching/'dendritic paradigm') ultimately entails the conception that different societies, through their unequal development, travel through time in a different way.[674] It is only through mapping their particular temporal journeys, then, that one can come to an understanding of the various isolated facts which they leave behind. Each sociohistorical trajectory can be said to describe a specific temporal journey, unifying the disparate factual remains attached to it (i.e., site-locus, site organisation, settlement pattern, social networks). This temporal journey of a societal formation represents a 'concealed' organic process, whose various 'fragments of experience' can be observed and studied archaeologically. The integration of these facts, however, is only possible if one acknowledges their place in the temporal process. The palaeo-archaeological facts are interpreted as 'appearances' and the object-specific temporal trajectories as the *longue durée* 'realities' that save and explain them. This, in turn, requires the recognition of the respective 'nexuses' and their meeting points – a mode of reasoning that, *grosso modo*, confirms the organicistic underpinnings of *« Paléohistoire »*.

Reconstructing societal evolution in this manner relies on a general understanding of societies as temporal organisms, whose 'modes of existence' author particular 'modes of becoming' (historical ontogenies).[675] Since the latter are object-specific, each societal organism largely *self-determines* its long-term history – societies, as temporally extended 'structures,' represent *self-regulatory* entities.[676] This aspect is crucial because the 'tempo' and 'mode' of social evolution consequently depend on the

[669] This 'resonating' interface between nature and culture typically leads to the acceptance of 'feedback loops' and other 'counteractive' effects. An example is Marchand's (2014: 111) insistence on the role of *« rétroaction »* ('retroaction') in past human-environment interactions.

[670] 'Organicism' re-interprets the 'contextualistic' categories of 'novelty' and 'change' in terms of the temporally extended 'organic' wholes it reconstructs. This gives way to the recognition of the inherent *alterity* (or 'otherness') of individual sociotechnical trajectories (see next section in this part of the chapter). The regulative role of 'otherness' – in contrast to 'sameness' – is for example reflected in Marchand's (2014: 427) notion of the *« insondable altérité »* ('immersurable alterity') of past sociohistorical configurations. Such conceptions embody an implicit critique of 'Neo-Darwinian' research agendas which often stress 'progress,' 'modernity,' 'inevitability,' and the 'unity of history' (cf. e.g., Valentin 2011: 5, 21).

[671] 'Organicism' is generally *non-prescriptive*. As Pepper (1942: 296) notes: "[...] [organicists] do not prescribe the path of knowledge. Nor do they believe they are prescribing anything at all; they are merely pointing out what actually goes on among the facts of the world. Their argument is through and through illustrative."

[672] The credo is that time remains poorly understood as a single temporal arrow but rather consists of multiple 'focused' temporal arrows. The claim that time itself is *heterogeneous*, suspiciously Bergsonian in orientation, is then no conceptual stretch anymore. The idea of temporal heterogeneity is of course difficult to reconcile with 'mechanistic' theories of time, which tend to 'objectify' the latter – time is typically viewed as a structure-giving feature of the world, rather than being 'structured' itself.

[673] 'Organicistic' approaches such as *« Paléohistoire »* extend the 'contextualistic' notion of *historicity* – i.e., the necessary 'situatedness' of a 'historical act' – to the *longue durée* and re-cast it as a feature of extended sociohistorical trajectories. In this way, historicity comes into view as a consequence of building up a temporally extended whole by striding through temporally enchained contexts of action (what in 'contextualism' would be seen as the 'spread' of a context). In 'organicism,' historicity in therefore means that different 'situated' contexts grow out of each other and thereby form a whole that is both 'organic' and 'situated.' The guiding metaphor is life-theoretical – society is understood as a 'living organicism' that is born, growths, and ultimately dies. All of this reflects the 'organicistic' root-metaphor of the 'living being' (see Chapter 2; cf. Pepper 1942: 280).

[674] Cf. Testart (2012: Fig. 29).

[675] Note that notions such as 'mode of being' or 'mode of existence' are deeply buried in French intellectual history and have recently re-surfaced, for example in the work of Bruno Latour (1991 [1992], 1994, 2011, 2012 [2013]) and Isabelle Stengers (1988, 2003 [1997]). Similar ideas, although applied to aesthetics and technology, have already been developed by Étienne Souriau (2009 [1943]) and Gilbert Simondon (1958) at the turn to the second half of the last century. Especially the latter constitutes an important historical source of terms/concepts – e.g., *« réalité technique »* ('technical reality') – that freely circulate in the French lithic scene (cf. Leroi-Gourhan 1993 [1964/1965]; Boëda 1993, 1997).

[676] See Chapter 2: esp. **Box 9** for the signification for self-regulatory principles of explanation in 'organicism.'

society in question, on its existence in the *durée*. All societies emerge, rise, consolidate themselves, experience crises, and are ultimately wiped from reality, but they are regarded to set the note and to be *their own rhythm-givers*. The same holds true for their 'significant' parts, for the *genesis* of societies is viewed to be complicated by 'conflict' and counteractive forces – societal becoming is nothing less than an ongoing attempt to overcome the two (Pepper 1942: 290). For similar reasons, both wholes and parts are considered *autonomous* and 'active' in their own right;[677] it is only when the 'ideal' of society (and thus the overall integration of parts) is reached that there can be no difference between the whole and its parts anymore. All of this leads to the *pluralisation of time*, to the delineation of distinct *temporalities* tied to different phenomena and/or domains of reality – a signature disposition of organicistic thought:

> "[...] But there is a double problem here: firstly, neither the time scale nor the nature of time are the same depending on whether we observe climatic changes (cyclical), plant evolution (linear and very slow), the evolution of faunas (also linear but much faster) ... There is not <u>a</u> time of prehistory, which is relevant for all phenomena studied, let alone for human phenomena. Secondly, the causes of change are also not the same: neither the variations of the Earth's orbit, which are at the origin of the climatic cycles, nor the laws of sexual reproduction, at the origin of the transformations of biological species, can claim to explain the "evolution of bifaces" or the transition from an economy of predation to an economy of production. There is therefore an autonomous area of inquiry, that of the "cultural time," of its nature and its rhythms." (Perlès 1998: 17f.; my translation; original emphasis [for the original French quote, see **Appendix Q.18**])

Perlès' symptomatic statement suggests that different aspects of reality (what organicists would identify as 'significant' wholes) are powered by different 'organic' processes and therefore engender their own temporalities (cf. e.g., Audouze and Valentin 2010: 34f.; Rocca 2013: 28 for a similar argument); they may even obey to *different rules of development* altogether. This idea is already outlined in the *œuvre* of the 'Early' Leroi-Gourhan, culminating in the latter's account of technology-language co-evolution in *Le geste et al parole* (1993 [1964/1965]). Leroi-Gourhan, too, proclaimed that human technicity has its own 'mode of existence' and is subjected to domain-specific laws and regularities of development (*ibid*.: 147).[678] This domain-specific temporal behaviour was captured by his notion of the *« tendance »* ('technical tendency'), which he opposed to the *« faits techniques »* ('technical facts') (Leroi-Gourhan 1943/1954; cf. Audouze 2002: 283; Stiegler 2009 [1994]: 69). The relationship between the two is that between a 'concealed' but directed organic process and its isolated 'fragments of experience.' This reiterates the organicistic conception that there is always unity to be found in diversity – i.e., that the unity of technology is made possible by the diversity of technical facts.[679] We will return to this point in the next section.

What is perhaps most important in the current problem context is that Leroi-Gourhan (1964/1965), based on these considerations, developed a general account of evolution, in which evolution was diagnosed to be governed by a plurality of distinct 'cycles' and 'epicycles' of becoming. This argument on the 'cyclicity' of time has been very influential and, at least tacitly, underpins the periodisation of the Western European Upper Palaeolithic in terms of its temporal sequence of great 'civilisations' (*civilisations*)[680] – i.e., 'Lower' vs. 'Upper Perigordian,' or the succession of 'Aurignacian,' 'Gravettian,' Solutrean,' and 'Magdalenian' (Leroi-Gourhan et al. 1976; cf. Bon 2009; Debout et al. 2012) – including their internal sub-division, typically into 'archaic'/'initial'/'proto-,' 'developed,' and 'final'/'epi-' phases respectively (e.g., Valentin and Pigeot 2000; Bon 2006, 2010; Langlais 2010, Klaric 2013). All of these different 'civilisatory trajectories' are formed by the relationships between the tem-

---

[677] The notions of 'object-specific' and 'object-inherent' *activity* [*Eigenaktivität*] can be considered a typical result of refining the structural categories of 'organicism.'

[678] Cf. "[...] Technoeconomic determinism is a reality whose effect upon the life of societies is deep enough to bring into existence *structural laws to govern the material world as firmly as moral laws govern the behavior of individuals toward themselves and their follow beings*. We may recognize that thought has as much reality as the material world, we may even assert that the latter owes its being to the effects of the former, but the fact remains that thought is reflected in organized matter. It is the organization of matter that, in various ways, directly shapes all aspects of human life." (Leroi-Gourhan 1993 [1964/1965]: 147, emphasis added)

[679] The difficulty to think of the world in its 'wholeness' [*Ganzheit*] while coevally acknowledging its diversity and 'multiplicity' [*Vielheit*] is a classic problem of 'organicistic' thought and can be traced back to the philosophies of Leipniz and Spinoza.

[680] 'Civilisation' is a key notion since it underscores the 'pro-active' dimensions of society-making. Society is seen as the product of a 'civilising process' (*sensu* Elias [1939] 1969) whose proper temporality is the *longue durée*. The concept of 'civilisation' will be discussed in detail below.

poral pathways of their 'significant' parts, by how these parts interact, possibly interfere or overlap with one another, or even fuse. In *Le geste et la parole*, Leroi-Gourhan explicitly introduces the idea that 'technological time,' at a certain point in human evolution, becomes critically detached from 'cultural time' which is largely defined by the rhythms of art-making (cf. Bidet 2007). The 'epicycles' that govern the latter are argued to be distinct from the 'epicycles' that propel the evolution of lithic technology.

The general conception of 'offset' trajectories of change, corresponding to different domains of reality or kinds of archaeological objects, has recently been re-invigorated by various French scholars. Naudinot and colleagues (2017b), for example, have called attention to the fact that at the far edges of North-Western Europe processes of 'Azilisation' – i.e., the gradual and persistent transition from the Final Madgalenian and Hamburgian to the latest glacial and early post-glacial human societies (Azilian/*Federmesser*) – have produced a marked 'time lag' between technical and symbolic developments. They present evidence suggesting that technical developments were much faster and have set the tone, whereas the evolution of 'artistic' expressions clearly lagged behind; the authors highlight that this *decoupling* of distinct material trajectories is of critical importance if we wish to understand the coalescence of what is called the 'Azilian' phenomenon (*idem*; cf. Valentin 2008a). In an earlier paper, it is even alluded that the lithic developments leading to the Azilian likely have to be explained in terms of general 'technical tendencies,' rather than being the product of regional peculiarities (including eco-climatic factors) (cf. Naudinot et al. 2017a). Different material trajectories may thus signify different aspects of past realities; it is their 'individuation' and temporal differentiation which is important to recognise and examine – otherwise, it remains impossible to understand whether similar 'appearances' have different significations in different evolutionary contexts.[681]

A second example is the work of Teyssandier (2003, 2007) and Bon (2002, 2010, 2015) on the evolution of Aurignacian societies in Western and Central-East Europe. These authors have proposed that the emergence of the 'Aurignacian package' cannot properly described by a 'revolutionary' scenario, but rather conforms to a gradual and step-wise process, in the course of which several distinct material trajectories of change meet at different points in time (Teyssandier 2007; Bon 2010).[682] The key concept is *arrhythmicity*. Historical processes of varying scales and temporalities are regarded to operate asynchronously (Bon 2015: 11; cf. Discamps et al. 2014), cumulating developmental potential to perhaps merge into something new over time (cf. Audouze and Valentin 2010: 41-43).[683] This account renders the Aurignacian the product of 'organic' social evolution, its organic structure is explained by invoking a number of developmental 'stages,' reflecting the temporal coalescence of the 'effective' material parts (i.e., lithic technology, organic technology, hunting strategies, settlement organisation, ornamentation practice, art-making, etc.) (e.g., Teyssandier et al. 2010). The 'coalescence' of these parts is thought to be a consequence of each part's own 'logic of change' – it consists in the *coordination* of the 'nexuses of change' which are proper to each part of the larger whole.

This coordination of 'nexuses' is seen to entail 'struggle' and the fragments thus often persist in basic 'conflict' to one another – the integration of all parts, therefore, can only succeed in *duration* (i.e., as a function of the full sequence of Aurignacian development). This is why social evolution has to be heterogeneous, partly asynchronic, and multi-temporal. The impossibility of integration at one given point in time turns out to be the *precondition* for a successful integration at a later point in time.[684]

This organicistic logic, namely that understanding 'conflict' is a necessary prerequisite for comprehending evolutionary 'integration,' issues a research mandate largely opposed to correlational epistemologies. Boris Valentin (2008a: 41) is quite explicit about this orientation. After reviewing the general epistemological situation of Palaeolithic archaeology, he advises its practitioners to pay primary attention not to similarities and vivid correlations, but to developmental discrepancies, inconsisten-

[681] The differentiation of time and the study of distinct temporal 'structures' is therefore an indispensable 'organicistic' instrument for assessing the 'equifinality' of 'appearances' and parts of larger temporal wholes.

[682] The evolution of the Aurignacian in Western Europe is explicitly pictured as a 'determined' and 'irreversible' process (Bon 2015: 11, 13) – two cornerstones of an 'organicistic' interpretation of social evolution.

[683] 'Arrhythmic' evolutionary scenarios have also been proposed by Langlais (2010: 283) in order to understand the development of lithic technology during the Magdalenian at the foothills of the Pyrenees.

[684] Cf. "[The] nexuses reach out from fragments like tentacles and encounter contradictions for the fragments. The progress of integration is not smooth and continuous, but is a buffeting of fragment against fragment, producing conflict and contradiction which is only resolved in an integration. The nexus of a fragment leads it inevitably into conflict and contradiction with other fragments." (Pepper 1942: 292)

cies, and contradictions – to what he denominates *« décalages »* ('mismatches'). These are often overlooked because researchers are trained to search for 'matches,' yet their interpretive significance cannot be overrated.[685] This view comes in various degrees of radicality but it is usually tied to an explicit critique of the 'heteronomic' assessment of temporally unified contexts in terms of causalities and/or first-movers (*idem*; Marchand 2014: 111, 151).[686]

A third example is provided by Perlès' recent essay on the nature of archaeological time, entitled *Tempi of Change: When Soloists don't play Together. Arrhythmia in 'Continuous' Change* (2013). This paper examines the ornamental and lithic evidence from Franchthi cave (Greece) in order to assess how the two domains of material culture change throughout the archaeological sequence. Perlès concludes that the two develop in fundamentally different ways and ultimately exhibit divergent 'rhythms' of change; she even contends that their respective 'modes of change,' although clearly authoring separate 'focused' arrows of time, can hardly be 'objectified:'

> "If several tempi of change can be identified in single technical production[s] such as stone tools and weapons, others again if one introduces symbolic productions such as ornaments, how many different rhythms of change should we expect when whole societies are considered? In particular, why would societal transformations necessary follow a ternary temporality, just as we have – according to Occidental thought – a past, present, and future, and just as we tend – still in Occidental thought – to divide time into Early, Middle, and Late?" (Perlès 2013: 297)

The second part of the title – *When Soloists don't play Together* – reassures us of the general autonomy of different material agencies but also introduces an illuminating metaphor – that of 'music' or 'music-making.' Why is this metaphor illuminating? First, because it is invoked to convey how distinct object-categories handle time and, secondly, because music is a prototypical example of an 'organic' phenomenon.

'Pure' music is organic in a fundamental sense: it requires *composition*, *creativity*, and *coordination*, especially when multiple voices and/or instruments take part in its making; pure music is also processually 'organic': its quality is bound to its temporal unfolding, most participating voices and/or instruments unequally contribute to this quality, and it is typically divided in determining 'scores,' whose structure and nature cannot be changed without changing the quality of the musical whole. Furthermore, a piece of music has certain 'synthetic' qualities such as 'melody,' 'pitch,' 'tonality,' and 'rhythm' (cf. Scruton 1997: 1-79) which follow from the rules of the piece (Arewa 2014), but these qualities generally differ from the individual qualities of the instruments and voices that have engendered them. Music is therefore both 'synthetic' – it is 'more than the sum of its parts'[687] – and inherently *temporal* – it can only be appreciated in its duration.

The music metaphor intuitively calls attention to concepts of 'orchestration' and 'multivocality' – to the dialectics between 'coordination,' 'tension,' and 'suspense' – which only in combination and over time give rise to a complex musical whole.[688] Music is organised sound brought into existence by combining and connecting tones in a distinct order (e.g., Levinson 1980: 6);[689] 'melody' is a result of

---

[685] The key point, although not fully developed, may even be that conflicting and contradicting evidence must be regarded the *status quo* rather than the exception; to acknowledge this pristine fact, however, would of course imply a fundamental shift in the focus of inquiry. Away from the search for 'matches' towards the careful documentation of cases of unsuccessful correlation.

[686] 'Heteronomy,' in contrast to autonomy, is the conception that phenomena are 'other-directed,' or 'shaped' and 'controlled' by forces/agents external to these phenomena; 'heteronomy' denotes the belief that a phenomenon's behaviour must be governed by something independent of the phenomenon. This principles implies the repudiation of 'self-determination' and 'self-directed' behaviour as features of explanation – both popular categories of 'organicism.'

[687] Surprisingly, the 'synthetic' quality of music is rarely addressed by theories of music. For an exception to this tendency, see Scruton (1997: 19-79, 2007) and Davies (2001: 47-71).

[688] Take the example of an orchestra, in which different instruments and musicians contribute to the final musical product. This 'musical whole' is not merely the sum of its parts but is literally *created* through the 'orchestration' of all of its parts, a process that already presupposes the whole. Moreover, each configuration of instrument and musician is different and each group of instruments contributes something else; this 'something else,' however, must accord with the musical potential of each instrument, for example with how the latter is able to build up, change, and maintain 'melody' and 'rhythm' and how this, in turn, chimes/resonates with the rest of the assemblage of instrument-musician hybrids. The resulting organic interaction therefore depends on the 'musical reality' of *each* of the participating hybrids. Needless to say, in reality the situation is typically even more complicated: there are, for instance, different 'roles' in an orchestra (e.g., groups of players, soloists, and a conductor). Clearly, this *inherent complexity* is another facet lending itself to 'organicistic' reconstructions. In order to make his point, the 'organicist' would ask: how can we unify the heterogeneities among the parts in an extended process of orchestral music-making?

[689] This definition of music focalises 'structural' aspects – a full-fledged definition of music, which is not the main concern here, would also need to take into account the 'intentional,' 'historical,' and 'cultural' dimensions of the same (e.g., Davies 2012).

the precise succession of tones and intercalated pauses within a fixed timeframe, from the 'chord' of tones of different pitch-levels (scales) 'polyphony' arises, and the relationships among the tones themselves define the 'harmonics' of a musical piece. To speak in organicistic terms, the 'tones' represent the 'fragments' which in isolation make little sense but through their *order* and *location* drive forth the temporally extended musical whole. Drawing on the music metaphor, 'organic' evolution can be analysed in terms of 'rhythm,' 'multivocality,' 'harmonics,' and global 'melody.' Perlès' paper (2013) on the long-term evolution of material culture at Franchthi addresses at least the first three aspects while paying special attention to 'multi-vocal' developments – as indicated by the title-phrase.

To conceive of technical evolution as a 'music-like' phenomenon[690] implies to regard it as an internally structured process operating according to an 'internal logic.' This construal establishes a conceptual triad to shed light on long-term developments in the sociotechnical domain – it makes room for analysing organic evolution as the interplay between the 'inherent rhythm' [*Eigenrhythmik*], the 'logic of development' [*Entwicklungslogik*], and the 'inherent dynamic' [*Eigendynamik*] of a given historical trajectory (including its sub-trajectories). The nature of a temporal phenomenon becomes a question of its *genesis*, that is, how its parts 'individualise' the whole over time.[691] The identification of technical evolution as 'music-like' generally implies to consider the technical sphere as temporally 'alive.' Musical metaphors simply draw attention to the fact that sociotechnical developments may be better understood if the wholes that frame these developments are recognised as distinct quasi 'living beings:'

> "Slow or fast, calm or bumped, the possibly changing rhythm of this prehistoric history remains to be measured much more finely, and the circumstances of its eventual upheavals deserve closer explications. This is what the palaeohistorical ambition aims for when it is firmly supported by palethnology." (Valentin 2008a: 28f.; also cited in Bon 2009: 185; my translation [the original French quote is provided in **Appendix Q.19**]).

Apart from Perlès (2013), musical reasoning is clearly reflected in the recent work of Langlais et al. (2012, 2016). These authors mobilise musicological terminology in order to analyse the long-term development of lithic technology in the southwestern fringes of France; they invoke two concepts – 'metronome' and 'syncopation' – to help interpreting the dynamics of sociotechnical evolution in the Magdalenian. The concept of the 'metronome' serves to characterise the 'role' of lithic technology in the evolution of the Magdalenian as a whole. It is argued that particular elements of lithic tool-kits can be used to measure the 'tempo' and 'mode' of Magdalenian social evolution (Langlais et al. 2016). The term 'metronome' thereby indicates that long-term developments in the lithic domain – especially those pertaining to systems of lithic weaponry – are structured into object-specific time intervals, intercalated in such a way that they generate a highly diagnostic rhythmicity.[692] The evolution of lithic technology is thereby thought to 'set the tone' because its directed 'mutation' creates new 'opportunity niches' (*sensu* Arthur 2009: 174-176) and the requirement to adapt other domains of society to them[693] – particular aspects of lithic technology – as *pars pro toto* – are considered to catalyse the whole of

Music, to this effect, is 'more-than-just-structural' – a point that Levinson (1980: 6) has insisted on and that is generally consistent with a 'synthetic' view of music.

[690] It is possible that the music-like character of long-term technical developments represents a special case of 'cyclic' evolution (cf. Perlès 1998: 18). Taken some of the evidence presented below, one may legitimately ask whether *musicality* can be considered to capture part of the 'organic' domain-specificity of technical evolution.

[691] The 'individualisation' of a whole can be understood as its ontogeny, a process during which the whole develops its key features and qualities and comes into view as something *different*. The 'becoming' of a whole, in other words, emerges as a key condition of differentiating wholes in 'organicism.' Differences between wholes are the result of divergent developmental trajectories. Synchronic comparison, therefore, remains necessarily partial and inconclusive. Analysing and comparing the discrete 'shapes' and 'traits' of lithic artefacts would be an instance of such practice; it is therefore unsurprising that 'organicists' typically see little merit in such an undertaking.

[692] See e.g., Valentin et al. (2004) for a similar reconstruction.

[693] The guiding concept is 'internal adaptation,' taking up the core intuition of society as a system. The general rationale can be illustrated by the example of the relationship between lithic domains and subsistence/hunting domains. The idea is simple: if lithic technology changes, it creates new opportunities to hunt animals – perhaps to hunt different animals, perhaps to hunt the same animals in novel ways. Lithic changes may also render long-hold practices untenable because they can no longer be 'supported' by the available lithic technologies. But this conflict must be discovered and the tension experienced. It nonetheless implies that some changes in the lithic domain will cause a re-organisation of the hunting domain – to ensure compatibility and/or to maximise synergies between the two. Synergetic co-evolution can for example be proposed to explain somewhat parallel developments in the domains of lithic weaponry and organic implements (e.g., Langlais et al. 2012: 146). However, in order to know what is adapting to what and why, one generally needs to know the timing, tempo, and mode of changes in each domain. The evolutionary scenario is 'organicistic' since it emphasises transformational necessity (evolutionary 'directedness'), contradiction and conflict among domains, and the gradual and sometimes delayed integration of these domains.

societal evolution. The latter is consequently often 'irregular,' 'unsteady,' and not fully predictable, even though sociotechnical evolution is generally pictured as a determinate process (cf. Langlais 2007, 2010).

The concept of 'syncopation' is more intricate. A 'syncope' is a musical figure conveying a rhythmic design which breaks with the prevailing schemes of accentuation, deliberately creating 'tension' and the potential for novelty. Processes of 'syncopation' can hence be described as tacit but irreversible transitions within a larger composition. Langlais employs the term to designate ongoing or sudden shifts in the 'rhythm' of lithic development as they unfold in time; 'syncopation' is effectively used to identify and describe 'stage'-transitions in the larger evolutionary scheme of Magdalenian societies of southwestern France (Langlais et al. 2012: 146). The notion of 'syncopation' thus encapsulates a classic organicistic pattern of reasoning: it seeks to coevally capture the *gradual* and *saltatory* character of evolutionary transitions (cf. Perlès 1998: 21). For organicists this attempt is not paradoxical – to the contrary, it is regarded to do justice to the fact that each transition must necessarily be built-up but also brings qualitative novelty. In this way, 'organic' evolution brings forth stage-like but interconnected temporal structures. Each novel stage of lithic development issues a new musical 'score,' yet all 'scores' remain part of the same evolutionary composition. This attempt to think continuity and change together – as two aspects of the same process – is typical for organicism, in which 'unification' is generally reached by keeping the delicate balance between the 'progressive' and the 'ideal.'[694]

The conceptualisation of continuity and change as complementary characteristics of temporal wholes is common-place in the French specialist literature. It is, for example, reflected in the popular phrase 'unity and diversity' (*unité et diversité*), often found in titles and headings of lithic studies (e.g., Slimak 1998/1999; Bon 2000; Klaric 2003; Marchand and Tresset 2005; Teyssandier 2006; Bon et al. 2006; Forestier et al. 2010; Bachellerie 2011; Bereiziat 2011; Tomasso et al. 2014). The slogan has almost assumed a signature status;[695] it expresses an insight that only organicistic thought has come to embrace in its radicality: the fact that 'conflict' presupposes higher-level unity and the possibility of 'unity' presupposes disintegration and scatteredness. Organicism recognises the basic contradictoriness of 'unity' and 'diversity,' but maintains that their contradictory nature is a result of a 'static' perception of world affairs (e.g., Copleston 1994 [1974]: 181, 186). If we acknowledge time as a structure-giving force, conflicting elements of reality can be integrated as time goes by.

A 'dynamic' view of time, therefore, removes the difficulty and puts 'diversity' and 'unity' as co-constitutive features of reality into perspective. 'Unity' is granted by an interconnected and temporally coherent 'organic structure,' diversity is sustained by the incompatibility of most of its 'fragments of experience.' Organicistic analysis demonstrates that the latter are 'fragmented' merely in experience and in reality turn out to be singularities of their past and multiplicities[696] of their future.

With Bergson (1934: 185), we can say that each 'fragment' and each configuration of 'fragments' is a testimony of the entirety of its past, yet also entails the full potential of its future development.[697] This not only delivers a basic critique of 'presentism'[698] – that is, the attempt to derive general principles and/or laws of reality from an observation of the present – but also clarifies the signification of evolutionary mechanisms in organicism. An evolutionary mechanism is what explains the observed temporal organisation of fragments in light of the totality of their 'nexuses,' so that the past, present, and future of each fragment can come into view as *one*. When Valentin (2008a: 27, 33f., 2015) insists on the specification of historical mechanisms to explain long-term societal developments (cf. Audouze

[694] To regard continuity and change as two sides of the same coin may easily result in 'punctuated equilibrium' models of evolution; it cannot overemphasised, however, that the types of 'punctuated equilibria' that 'organicism' typically advocates tend to differ from the 'punctuated equilibrium' models of evolutionary biology. The main reason is that 'static-ness' – as emphasised for example in Eldredge and Gould's (1972) seminal paper on the issue – cannot be foregrounded in 'organicism' since the theory is basically motivated by a fundamental critique of 'static' perception.

[695] Complementary phrasings are 'unity in diversity' or 'diversity in unity.'

[696] The concept of 'multiplicity' calls attention to the fact that each 'fragment' embodies multiple developmental potentials. This potentiality is not fully determined, yet different 'fragments' yield different potentials. 'Potentiality' is a concept proper to 'organicism' and delineates the *space of possible developments*. It is notoriously difficult to analyse and typically requires a general understanding of the behaviour of certain types of 'fragments' and the constraining effects of specific fragment-context.

[697] Bergson's (1907, 1922, 1934: 185) contention is that reality is 'becoming' and that everything necessarily exists in duration (*durée*). The past always persists in the present and the present is always carried over into the future (cf. Copleston 1994 [1974]: 182, footnote 1).

[698] The critique on 'presentism' primarily targets research agenda's that trust in 'uniformitarianism' and base their interpretations on comparative frames of reference, constructed in the here and now – two strategies that are regularly combined in 'formism' and especially in 'mechanism.'

and Valentin 2010), he thus simply means to lay bare an initially 'concealed' organic process which coherently accounts for the global organisation of fragments. This call to mechanisms should therefore not be confused with the 'mechanistic' perseverance on causally-specific principles of explanation.[699]

This organicistic conception of evolutionary determination is explicitly laid out in Valentin's *Jalons pour une paléohistoire des derniers chasseurs* (2008a), the founding document of *« Paléohistoire »*. According to Valentin (*ibid.*: 13f.), if one wishes to comprehend a 'palaeo-historical' trajectory and why the associated social systems change in the way they do, one has to study *« préfigurations »* ('pre-configurations'/'anticipatory capacities'). The idea here is that each system state – each developmental 'stage' – of a sociohistorical trajectory is *preconfigured* through its preceding stage and *configures* its succeeding stage.[700] This can be understood as a process of *systemic inheritance* – each system state inherits something from its past and passes on something in order to have a say on its future. This conception counters *tabula rasa* views on human history and maintains that each system state is defined by a particular set of material, social, and cognitive resources that are a function of its temporal position in the 'palaeo-historical chain' (*sensu* Valentin 2011: 80).

Each system state, picking up a conception already encountered in the last part of this chapter, enters reality 'pre-furnished.' As we have seen, the mode of 'furnishing' proper to long-term trajectories is *self-furnishing*. The concept specifies what evolutionary *self-determination* amounts to in organicism. Since each system state is already pre-configured, its future development is constrained by the nature of the configuration. The study of *« préfigurations »* is thus nothing but the study of how an evolving social system pre-furnishes itself through time – with specific objects, practices, norms, concepts, and needs.[701] In the words of Audouze and Valentin (2010: 35), each evolving system embodies the "concretisation of a system of values," reflected in a repertoire of *« manières de faire »* ('ways of doing things') and *« manières de voir »* ('ways of seeing things').[702] The becoming of a 'palaeo-historical' trajectory, in other words, corresponds to the crystallisation of societal resources specific to this trajectory. This is why different societal pathways inescapably inaugurate an *« insondable altérité »* ('immersurable alterity') (Marchand 2014: 427) – an alterity that can only be illuminated if the trajectories are studied from the *inside*. This basic alterity is another reason why 'universalist' and/or 'externalist' analysis is met with great scepticism:

> "[...] During the Late Glacial period between 18,000 and 14,000 calBP, the archeological record of several different aspects of hunter-gatherer activities attest to an internal evolution between the Middle and Upper phases of the Magdalenian in the South-west of France. Throughout these four millennia, rapid changes are perceptible in hunting weaponry, which may be tied to the syncopation of techno-economic choices outlined above. Dynamic technical solutions, evident in these various forms of hunting weaponry, highlight the significant technological creativity and innovation inherent in these objects vital to hunter-gather groups. Understanding of the forces driving these changing trajectories still remains limited and can only be further advanced by integrating non-environmental factors such as personal ornamentation, mobiliary and parietal art, or funerary practices, all of which were undoubtedly instrumental to these hunter-gatherer groups [...]." (Langlais et al. 2012: 146)

How a social system reacts to changing external conditions is then not only a matter of the external conditions themselves, but becomes a question of how the system can *cope* with these conditions. Whether and how particular external conditions can be dealt with depends on the resources and types of pre-configurations the system has inherited. Together, they specify the capacity of the system to modulate and, if necessary, re-organise its internal relations (cf. Marchand 2014: 13, 2017: 9). From this perspective, external conditions *as such* become secondary since their effects greatly depend on the available societal furniture – on what Bon (2009: 243) calls the 'bark of the social tree'; the latter is 'primary' because it constitutes a historical *a priori*. Human-environment interactions consequently

[699] With Pepper, we can say that the insistence on certain determinative principles both in 'mechanism' and 'organicism' is the result of their shared 'integrative' commitment. The fact that this affinity turns out to be deceptive is the consequence of divergent concepts of 'truth' and 'assertibility' adopted by both theories.
[700] The distinction between *preconfiguring* and *configured* is the conceptual equivalence of the distinction between *determining* and *predetermined* flakes discussed in the previous section – the two differ merely with respect to scale of the 'organic' wholes they seek to illuminate.
[701] This 'self-furnishment' is not necessarily 'linear' and 'cumulative,' specific practices and concepts may also be discarded, abandoned, and/or lost/forgotten. Logically, however, what can be forgotten must first be 'furnished.'
[702] For the distinction between *« manières de faire »* and *« manières de voir »*, see esp. Pelegrin (1995: 35f.). For the distinction between *« vouloir faire »* ('volition-to-do') and *« savoir-faire »* ('know-how'), see e.g. Ploux and Karlin (2014).

come into view as fundamentally *mediated* by larger sociohistorical trajectories. Not every society will react to the same external conditions in a similar fashion (Langlais 2010: 14) – a fact that is considered to generally undermine the ability of scholars to predict such reactions.[703] Adaptation, in this view, is a question of 'organic evolution' rather than 'cultural ecology' (e.g., Bon 2009: 265, 324).

This perspective entails a 'not-everything-goes' proposition of social change. The basic contention is that organic evolution *decreases* the ecological plasticity of societies – not every solution to an externally-defined problem is feasible or possible; the 'space of response,' in other words, is predefined by the nature of each evolutionary 'stage' and the entire evolutionary trajectory.[704] Although the respective concepts are hardly used by French practitioners, we may conclude that different social formations are considered to be differentially *resilient against* or *vulnerable to* different external transformations.[705] Additionally, different sociohistorical trajectories are expected to create their own, sometimes contingent *internal* problems (captured by the structural categories of 'conflict' and 'contradiction'). Again, evolving societies are not only pictured as problem-solvers, but equally emerge as *problem-generators* – many of the internal conflicts, inconsistencies, and difficulties an evolving society has to deal with and solve may be s*elf-generated*. In general, this view combines well with *technology-push* conceptions (*sensu* Freeman 1994)[706] of sociotechnical evolution. It redirects the explanatory focus to the *internalities* of past societies and their *longue durée* trajectories.

The emphasis of internally evolving 'palaeo-historical' trajectories has somewhat inversed the allocation of relative 'passiveness' and 'activeness;' societies, as a function of their 'organic' long-term development, are now regarded to represent the primary pole of activity – they are pictured as 'ever-moving,' self-organising entities imbued with creativity and a certain degree of 'animacy' – whereas environmental conditions, even though capable to enact certain obstacles, appear to be relatively passive contributors to societal developments (see esp. Bon 2009: 243 [introductory quote of this chapter; cf. **Appendix Q.5**]). This not only introduces yet another level of potential tension and 'conflict,' but shows that change and transformation are really viewed as the *modus operandi* of 'societal existence.' Societies change constantly of *their own accord* – transformation and alteration are regarded as an essential part of the nature of society. This again confirms the 'inherent activity' [*Eigenaktivität*] of sociotechnical realities, past or present. The corresponding mode of 'being alive' is often captured by the mobilisation of two complementary concepts: *technical invention* and *mutation*. Typically, these two concepts target the self-organisational capacities of varying 'technical milieus' (*milieus techniques*) (*sensu* Leroi-Gourhan 1943/1945; Gille 1978).

Already the 'Early' Leroi-Gourhan – in *Évolution et techniques* (1943/1945) – has insisted on the fact that each society harbours its proper 'technical milieu' equipped with the ability of deliberate expansion (cf. Audouze 2002: 285). 'Technical milieus' are defined by continuity with themselves and

[703] As discussed in Chapter 2, 'organicism' and 'mechanism' do not see eye to eye in the question of 'prediction.' Although both believe in relatively *strong determinacy*, they have come to reject each other's interpretation of the latter. Whereas 'mechanism' departs from assumptions of 'simplicity,' 'universality,' and 'uniformity,' 'organicism' commits itself to the analysis of determination in terms of 'complexity,' 'particularity' and 'heterogeneity.' Despite the occasional mobilisation of similar terms, both modes of cognition therefore conceptualise determination in vastly different ways – a fact that has important consequences for assessing the role of 'prediction' in lithic research.

[704] The idea of a 'space of possible responses' can be clarified with the concept of *« bricolage »* ('bricolage') (Lévi-Strauss (1966 [1962]: 19). 'Bricolage' is a praxis-oriented concept which maintains that problem-solving in traditional societies can only poorly be understood by invoking the metaphor of the 'engineer.' According to this popular conception, problem-solving is a process of independent design – problem-solution designs are typically developed from scratch and seek to be optimally efficient. 'Bricolage' is an alternative strategy according to which problem-solving is most likely to be successful when it actively builds on the pre-existing cognitive and material resources of a society. These can then be recombined or further developed in such a way that the respective problem can be overcome.

[705] Valentin (2008a: 19f.) explicitly draws attention to Lévi-Strauss' (1966 [1962]: 233f.) dichotomy between 'hot' and 'cold' societies. These two types of society differ in how they relate to their own historicity. 'Cold' societies try to conceal internal entropy and disorder in order to prevent change (often by means of equating historical time with mythical time). 'Hot' societies, by contrast, *cultivate* entropy and encourage change (which typically produces inequality). The distinction draws attention to the interlinkage between a society's 'deep structure' and its temporal development. We can say that the two society-types are differentially *resilient* against/*vulnerable* for changes in their external environment(s).

[706] The rivalling position favours a 'demand-pull' conception of technological change, according to which technical changes primarily occur when external conditions necessitate such changes. Although both 'technology-push' and 'demand-pull' conceptions are somewhat 'mechanistic' in their basic logic (they are based on the 'push-and-pull' metaphor), the former is often reflected in practical applications under the banner of 'organicism' while the latter is typically favoured in 'mechanistic' approaches. If one speaks of 'technology-push' in the context of 'organicism,' one should of course not interpret *push* in overly 'mechanistic' terms; 'organicistic' *push* is always also a question of *creativity* and *ingenuity*. We will return to this crucial point below.

temporal coherence (Leroi-Gourhan 1973 [1945]: 344).[707] This notion of the 'technical milieu' – which often makes its appearance in disguise of terms such as *« sous-système technique »* ('technical subsystem') or *« realité technique »* ('technical reality') – remains highly influential in French lithic research (e.g., Pelegrin 2004), conveying its basic organicistic orientation. Based on Leroi-Gourhan's foundational writings, one can assert that the inherent 'animacy' of the 'technical milieu' is a function of its *inner drive* to achieve internal technical coherence. This, in turn, is another way of saying that technical integration is typically achieved through ensuring *compatibility* between various techniques and technological sub-domains (cf. Leroi-Gourhan 1973 [1945]: 39f.) – such compatibility can be technological, functional, and/or conceptual. Even though the 'Early' Leroi-Gourhan did not pay particular attention to aspects of social compatibility (Latour and Lemonnier 1994: 12-16), the main point is clear: societies cannot simply be forced by external circumstances to adopt particular technical solutions. We might say that a 'technical milieu' can only bring forth *what it can creatively envision and what it is ready for*.[708]

This conception of society as an irreducible evolutionary agent in its own right – as a 'protagonist' of social evolution – is already encapsulated in the idea of *« civilisation »* (*sensu* Leroi-Gourhan 1936; Leroi-Gourhan et al. 1976),[709] which for many, especially Upper Palaeolithic, researchers has become an important surrogate for the concept of 'culture' (e.g., Taborin 1993, 1994; Bon 2009, 2010: 117; cf. Wisniewski 2003: 9-11).[710] In point of fact, the term 'civilisation' embodies an organicistic critique of contextually or otherwise narrowly defined concepts of culture; it expresses the organicistic dissatisfaction with an overly 'static' construal of the latter. While the classic idea of 'culture' places strong emphasis on fixed regulations and carries a 'destinatory' connotation, *« civilisation »* emphasises the *processual* and *ever-developing* nature of culture (cf. Braudel 1949; Mauss 2006 [1929/1930]).[711]

The employment of 'civilisation' is thus also an attempt to sidestep 'emphatic' or 'idiographic' understandings of culture, which are both considered to neglect the most basic, that is, everyday aspects of culture-in-the-making.[712] *« Civilisation »*, by contrast, depicts social becoming as an *effort* and puts the *life-practical building blocks* of society (*praxis*, *techné*) centre stage. By freeing human actors from the shackles of their inevitable cultural destiny, the concept of 'civilisation' brings into focus that societies are capable of forging their own future.[713] 'Civilisations' unfold in the *longue durée* and accumulate means to pro-actively *relate* to their environments, rather than merely buffering themselves against them (Ramírez Galicia 2016: 12, footnote 11; cf. Bon 2015: 11f.). The process of civilisation is hence a 'creative' process in which aspects of the environment (*milieu naturel*) are gradually integrated into the cultural repertoire of a society (e.g., via specific ways of working natural materials, depict-

[707] Cf. "[…] An essential property of the milieu technique is its coherence and continuity, resulting from the permanent relationship of each element with the totality of other elements and from their perpetual interactions […] Covariations [therefore] constantly occur […]" (Audouze 2002: 285).
[708] This conception takes up Margaret Miller's famous statement "[…] a culture takes in what it is ready for […]" (1997: 243), resulting from her research on cultural contact and exchange in the ancient Mediterranean.
[709] For a basic exposition of the concept of 'civilisation,' see esp. Elias (1969 [1939]) and Febvre (1988).
[710] *Contra* Straus (2002b: 1, 2005: 12).
[711] For helpful summaries of the idea of the 'civilising process,' see Hahn (2013: 26) and Law (2015: 278-280).
[712] 'Emphatic' and 'idiographic' conceptions of culture foreground 'art,' 'music,' and 'architecture' as key features of cultural architectonics (cf. Geyer 2010). They are often criticised to be 'eurocentric' since the core of their culture definition is based on what Europeans had long regarded as 'high culture' [*Hochkultur*]. Having said this, 'idiographic' understandings of culture often play a key role in general narratives of human evolution; Robert Kelly (2016), for example, has recently renewed this inclination. In his *The Fifth Beginning: What Six Million Years of Human History Can Tell Us about Our Future*, he distinguishes between the biological beginnings of humanity, which he associates with the dawn of stone technology (Chapter 3), and the cultural beginnings of humanity, which he identifies with the emergence of 'beads and stories' (Chapter 4). His account (*ibid.*: 36) attests to an 'idiographic' definition of culture which is inconsistent with the more inclusive conception of 'civilisation' instigated by basic *techniques* such as stone knapping.
[713] Tim Ingold (2016 (1983): 62) has paraphrased this history-making capacity of human society in the following way: "[h]istory […] does not just happen, it is *made* through the intentional activity of conscious purposive subjects – by people […] as historical agents, we act from within, as participants in our own creation: Collectively, 'man makes himself'. And although every individual agent has a transitory existence (as each of us, unconscious of the event, must make his entry and his exit), the history that we make, and that is made in us, transcends the bounds of our particular experience. It is […] nothing other than the process of *social life*. Moreover, this process cannot apprehended as an accumulated series of discrete, empirical events. Our subjective life is not contained within events but is conducted through them: It is a continuous, creative movement, like a task that is never complete." (original emphasis)

ing animals, modifying natural spaces such as rocks and caves, etc.). Natural environments thereby come into view as 'last' movers, rather than 'first movers.'[714]

'Technical invention,' as an antonym to Neo-Darwinian 'adaptation,' simply takes up what Leroi-Gourhan described as 'the capacity of the technical milieu to expand deliberately' (see *supra*). A 'technical invention' is the adoption of a technical novelty that can be integrated into an inherited 'technical milieu' – it spotlights the self-generative potentiality of the latter (cf. de Beaune 2008, 2012). The emphasis of 'invention' as a function of the creative potential proper to each technical context resonates with the ambition of French lithic experts to 're-humanise' the Palaeolithic past, to bring more clearly into focus the anthropological dimensions of technicity (e.g., Tixier 1980; Perlès 1991a; Inizian et al. 1999 [1995]).[715] Radically put, the concept of 'technical invention' adds an element of *serendipity* to the character of human evolution – 'inventions' can be interpreted as the product of unanticipated events or processes proving future utility.[716] A 'technical invention' in this sense can only be retrodicted – that is, diagnosed in retrospect – but hardly be predicted in all of its details.[717] Conceptually, it balances the determinative nature of the past and the creative potential of the present in light of a coming future, which is highly characteristic of organicistic thought. Clearly, the overall configuration of reasoning reflects a conception of evolution that is more Bergsonian than Darwinian.

For Bergson (1907), 'invention' is a key term, reflecting the capacity of evolutionary processes to break out of their developmental necessities. In *Évolution créatrice*, he defends a conception of becoming explicitly opposed to Darwin's (1859) evolution by means of natural selection. He highlights the centrality of *creativity* both in natural and human evolution – a fact that is reflected in his conception of the *« élan vital »* and his definition of *Homo faber* (Copleston 1994 [1974]: 198; Hussain, forthcoming). For Bergson, most importantly, human technicity is therefore primarily defined by technical creativity, opening up an almost inexhaustible space of combinatory possibilities[718] - it follows that 'the universe is not made, but is being made continually' (Bergson 1907: 255). The basic argument, later further elaborated by many other thinkers, is that technical objects (artefacts), in contrast to natural objects, are always *created* and *invented*, that is, they always contain a human gesture (Schick 2018).[719]

Bergson's critique on Darwin is reiterated by Bernard Stiegler (1994), one of the most influential voices of French technological thought today. Stiegler (2005) argues that selection in the technical world operates via 'adoption' rather than Darwinian adaptation (cf. Moore 2013: 18, 24f.). 'Adoption' is internally-directed and consists in the process of changing and/or adding technical means to an already pre-existing technical domain; it creates an evolving 'technical world' and thus a new logic of existence – what Stiegler identifies as the basic *technological condition* of humanity. 'Adoption,' ac-

---

[714] This rejection of the role of the environment as 'first mover' gives way to the repudiation of 'mechanistic' theories of social evolution altogether. Yet, it also leads to a refusal of 'formistic' theories that explain observed patterns by means of invoking the environment as a 'subsistent' category.
[715] This 're-humanisation' of the Palaeolithic past is for example reflected in the fact that *« Paléohistoire »* scholars have recently begun to convey time in *human generations* (e.g., Valentin 2008a: 11-14, 2011: 3; Marchand 2014: 14). This manoeuvre signals that society-making is understood as an *active* 'civilising process,' as the cumulated efforts of human individuals organised in generations. These generations are linked – that is, 'enchained' – via long-term historical trajectories.
[716] This conception of 'technical inventions' as creative and sometimes spontaneous discoveries which only later turn out to be beneficial or otherwise functional is typically not shared by Anglophone experts, especially not by those working under the 'mechanistic' paradigm. An example is the faithful rejection of 'technical inventions' as evolutionary driving forces by Kuhn and Clark (2014). Apart from rejecting the concept altogether, the only alternative seems to discuss 'technical inventions' in the context of 'demand-pull' models of technological change (see *supra*), according to which invention is virtually forced upon a given technical context since external factors render it inevitable: "[...] In general, technological innovation is most likely under conditions where risk is high because that is where people have the most to gain from effort invested in new technologies." (Kelly 2013: 122; cf. Fitzhugh 2001)
[717] This difficulty to predict a 'technical invention' is also a consequence of the possibility that different technical domains and sub-domains, as a function of their domain-specifity, may engender different *rates of innovation*, perhaps even different *logics of discovery*. Valentin (2011: 31) anticipates this problem: "[...] [the] general division of the Later Palaeolithic only imperfectly accounts for the documented regional and historical variations, and especially for transitions operating with different rhythms not only in varying regions but also relative to different *fields of invention*" (my translation; emphasis added [the original French quote is provided in **Appendix Q.20**]). This quote clearly shows that particular 'inventions' are thought to emerge at the intersection between 'man' and 'matter,' by recognising the particularities of them both – human ingenuity and creativity meets specific matter-potentials. The resulting interactive scenario which unfolds in the *longue durée* substantiates the view that the basic research orientation is 'organicistic' here.
[718] In all of his works, Bergson insists on an important element of *human freedom* (cf. Copleston 1994 [1974]: 187f.), but this freedom is not regarded to be unconstrained since it is enfolded in duration and can only persist through temporal continuity.
[719] Sigaut (2012) also draws attention to the importance of 'invention' in understanding human tool-use. He maintains that the human tool is never simply an organic adaptation, but always represents an *irreducible* and *original creation* and as such an 'invention' in the literal sense (*ibid.*: 18).

cording to Stiegler (2004b: 15), enables humans to constantly *re-invent themselves* on evolutionary time scales; 'adoption' and 'invention' are key processes of a fundamental 'techno-logical' mode of existence.

Bon (2009: 337), citing Maurice Godelier, ushers in a similar critique by emphasising the common bond between human life, technological production, and technical innovation, crucial for understanding the 'social morphology' (*sensu* Durkheim 1894)[720] of past societies:

> "[H]umans are not only beings who adapt, they are beings who invent themselves. Humans are beings who are incapable of living in a society without providing or receiving from their birth the capacity to produce this society in order to live." (Godelier 2007: 189; my translation [the original French quote is provided in **Appendix Q.21**])

The concept of technical 'mutations' (*mutation*), regularly found in French lithic literature,[721] expresses a similar logic. Perhaps even stronger than technical inventions, however, 'mutations' call attention to *auto-poeitic* processes of societal change.[722] The ancient Greek notion of *poeisis* implies an 'activity through which something is brought into existence which did not exist before.' The term 'mutation' indicates such an activity; it accounts for the *poeitic* capacities of organic processes of becoming to self-stipulate change; organic development is *auto-poeitic* in this sense. The notion of 'mutation' can hence be understood as the organicistic interpretation of the structural category of 'novelty,' originally proper to 'contextualism.' The added ingredient is the specific organicistic interpretation of time. 'Mutations' balance continuity and change. We realise this point when considering what initially appears to be the paradox of mutations.

This paradox consists of the fact that mutations themselves are generally difficult to predict – no single mutation is *per se* necessary to happen at a given moment in time – but entire organic systems are bound to mutate with relative certainty; we can thus say that although we are incapable to precisely anticipate when and how a system mutates, we are not surprised that it mutates at all. In addition, even though mutations may introduce something entirely new, these mutations always depend on what was there before. Put differently, there must be a pre-existing *something* that mutates – a 'substrate of mutation':

> "[...] What drives these observable changes [connected to the Madgalenian-Azilian transition] in material culture? How did this [Azilian] mutation operate on the Magdalenian substrate? [...] The precise connections between, on the one hand, climatic and ecological upheavals of the Late Glacial, and, on the other hand, other substantial mutations in the domain of symbols and techniques, naturally sit at the heart of all debates [...]."(Marchand 2017: 9; my translation [the original French quote is provided in **Appendix Q. 7**]).

Hence, 'mutations' appear to be paradoxical only when time is reduced to static simultaneity. They presuppose duration and temporal interconnectedness; they bind together past, present, and future and justify the discontinuity of continuously structured temporal wholes. Furthermore, 'mutations' echo the organicistic conception of determination insofar as they are always preconfigured by their preceding substrate and remain strongly determined by the temporal growth-patterns of their organic wholes. In theory, we should thus be able, for example, to determine the *rate* of mutation of specific wholes with a good amount of certainty[723] – thus, determination is clearly defined 'synthetically.' The fact that the frequency and perhaps even the nature of mutations may depend on the organic whole in which the respective mutations occur simply reiterates the organicistic preoccupation with the object-specifity of distinct objects of reality. Technical 'mutations,' in a similar way as 'inventions,' thus typi-

---

[720] Inquiry in the tradition of *« Paléohistoire »* is strongly influenced by the work of ethnologist Alain Testart (1982, 2005, 2012), who is regularly cited by Bon, Marchand, and Valentin. Testart builds a conceptual bridge to traditional French sociology in the wake of Durkheim and others. This tradition often considers society as a *quasi-living superorganism* – as a developing organic whole that is more than the combination of its parts. Testart's role cannot be underestimated since it was probably him who brought 'social evolution' to the agenda of French anthropology and, more recently, Palaeolithic archaeology. He was one of the last great thinkers in the tradition of comparative *« Sociologie générale »*. In a similar way as *« Ethnologie générale »* in the wake of Leroi-Gourhan has influenced the development of *« Palethnologie »*, Testart arguably played an important, although perhaps not yet fully developed role in the emerging strand of *« Sociologie préhistorique »* (cf. Bon, in the future).

[721] The term 'mutation' is for example mobilised by Bodu and Valentin (1997), Marchand (1999a), Valentin et al. (2004), Teyssandier (2007), Naudinot (2010), Langlais (2010), Pesesse (2010), and Bon (2015) – to name but a few.

[722] *Autopoeisis* is the ability of a living or quasi-living system to re-create itself. For a comprehensive definition and application of the concept, see e.g. Varela et al. (1974). For its role in the general theory of 'social evolution,' see esp. Luhmann (1984, 1990).

[723] From an 'organicistic' point of view, a relatively constant *rate* of mutation – always an emergent property of the whole – gives rise to a particular 'rhythm' of change. The notion of 'mutation' is therefore logically linked to the concept of developmental rhythms – an idea characteristic of the French tradition as we have seen.

cally emerge as a product of 'civilising processes.' Because organicism detects various degrees of 'animacy' in the phenomena it investigates, mutations are not confined to specific domains of reality, let alone to the realm of biology. 'Mutatability' is re-cast as a universal feature of evolving wholes, but the nature of mutation is considered to greatly differ among different kinds of wholes. The concept of technical 'mutation' (*mutation*) reflects the constitutive organicistic tension between regularity and particularity.

5.2.3 ***« Approche techno-génétique », technical lineages, and radical anthropology***

The third window into organicism has recently been opened by the 'techno-genetic' paradigm, developed by a small group of scholars around Éric Boëda (1997, 2005, 2013) in Paris-Nanterre (e.g., Soriano 2000, 2001; Forestier 2010; Nicoud 2011; Chevrier 2012). This paradigm is based on what has been termed the 'techno-genetic approach' (*approche techno-génétique*). This approach seeks to fill the void of classic *chaîne opératoire* analysis – to understand the 'finality' (*fonction*) of tools[724] – and to place both tools and the systems of their production into long-term processes of 'organic' lithic evolution. The emergence of the techno-genetic paradigm can be understood, on the one hand, as a reaction to Tixier's deliberate neglect of functionality, especially in the domain of lithic tool technology,[725] and, on the other hand, as a re-appraisal of the 'Early' Leroi-Gourhan's 'technological vitalism' (*sensu* Delitz 2015), including the latter's interest in the gestural and morpho-functional aspects of tool-utilisation (cf. Leroi-Gourhan 1968).[726]

As a result, the focus of techno-genetic research lies, often exclusively, on technical objects themselves rather than on past societies. This clearly separates the 'techno-genetic approach' from *« Paléohistoire » sensu stricto* – the latter departs from the 'Late' Leroi-Gourhan and his 'palethnological' legacy, whereas the former takes inspiration in the Leroi-Gourhan of *Évolution et techniques*. Since the techno-genetic endeavour is mainly pre-occupied with the evolution of lithic technology *per se*, we may speak of *« Technohistoire »* ('Technohistory') or *« Paléotechnologie »* ('Palaeotechnology') depending on the emphasis of inquiry.[727]

The techno-genetic approach entails a number of conceptual and methodological reorientations in how lithic technology is to be studied. The perhaps most important change in perspective concerns the conception of lithic tools themselves (cf. Boëda 1997: Chapitre 8, 2013: 45-53). Tools are no longer regarded to be the mere output of technical systems – i.e., the products of the 'confection' phase of the *chaîne opératoire* – but are taken into consideration as *systemic entities* in their own right (Chevrier 2012: 147).[728] They come into view either as technical 'micro-systems' or as 'sub-systems' of larger lithic production structures (cf. Lepot 1992/1993: Planche 87).[729] Tixier's 'anarchism' in terms of technological finalities has thereby motivated, first, the study of interactions between tool-systems and lithic production systems (Boëda 1991, 2005: 59-61, 2013: 35) and, second, the re-examination of the structure and morpho-functionality of tool-systems themselves. The latter has given rise to what is known as the 'techno-functional approach' (*approche techno-fonctionelles*) (Lepot 1992/1993; Boëda 1997, 2001; Bourguignon 1997; Soriano 2000; Soressi 2002; Pagli 2009; Lourdeau 2010; Bonilauri

---

[724] For the distinction between 'structure' (*structure*), 'operation' (*fonctionnement*), and 'function' (*fonction*) (*sensu* Sigaut 1991), see the previous part of this chapter.

[725] Cf. esp. Tixier (2012 [1978]: 33).

[726] Leroi-Gourhan's interest in tool-mediated 'modes of action' has given rise to an entire strand of research – commonly grouped under labels such as *gestural anthropology* or *« Technologie »*. This trajectory of sociotechnical thought leads from Mauss over Leroi-Gourhan to Haudricourt (1987) and Sigaut (1991, 2012), converging with some noticeable branches of sociology which investigate the status of sociotechnical systems (Rabardel 1995). The legacies of all of these thinkers have, to various degrees, shaped the techno-genetic paradigm – its motivations, methods, and goals.

[727] Techno-genetic reasoning represents a more definitive departure from 'contextualism' than *« Paléohistoire »*. While the latter embraces the multiplicity of developmental agents and trajectories shaping societal evolution, the former regards it as self-sufficient to address technological evolution *sui generis*. This has led to a shift in emphasis and research interest away from the ambition to write a proper 'palaeo-history of societies' towards the vision of writing 'palaeohistories of knapped stones.' This conceptual shift is for example notably reflected in the subtitle of Boëda's most recent book, *Techno-logique & Technologie. Une Paléohistoire des objets lithiques tranchants* (2013) – a key document of the 'techno-genetic' project.

[728] The recognition of the lithic 'tool' as a systemic entity automatically re-directs analytical attention to the problematic relationship between 'artefacts' and a 'tools' (e.g., Chevrier 2012: 135-138; see *infra*). Tools are generally regarded to be 'more-than-just-artefacts,' mirroring the 'synthetic' re-definition of the tool concept in this branch of French lithic research.

[729] The domain of lithic tools is considered to delineate yet another 'compartment' within the wider technical system – representing another building block of the *« système technicien »*, to speak with Jacques Ellul (1977). [For an explicit citation of the latter, see Chevrier (2012: 98)].

2010; Koehler 2011; Bodin 2011; Nicoud 2011; Chevrier 2012: 148f.; Rocca 2013; Leroyer 2016; Weyer 2016).[730]

Techno-functional inquiry is regarded to complement, and sometimes substitute, the functional and typological analysis of lithic tools (e.g., Boëda 2001; Soriano 2005; Boëda et al. 2015).[731] A tool is seen as a *technical microcosm* to be studied in its technological 'structure' (*structure*), 'operation' (*fonctionnement*), and 'function' (*fonction*) (*sensu* Sigaut 1991; cf. Boëda 1991, 1997: 30f., 2005: 47, 2013: 60f.)[732] – just like any other technical entity. Pivotally, the material 'appearances' of tools – which have largely been the target of analysis prior to the dawn of techno-functional inquiry – are viewed to 'conceal' much of a tool's 'structural,' 'operational,' and 'functional' complexity – an organisational complexity which is regarded to be crucial to decipher (Boëda 1997: 36, 110; Forestier 2010; Chevrier 2012: 12, 87, 99, 146).

The techno-genetic paradigm utilises the insights gained from techno-functional analysis to place varying tool-systems into their broader evolutionary context (Boëda 1997, 2013). This evolutionary context is identified with long-term technical trajectories regarded to reflect the organic 'becoming' of lithic objects *sui generis* (Boëda 2005). Accordingly, the primary evolutionary context of lithic objects comes into view as an extended temporal whole, perceptible only in the *durée* ('duration'). The key concept is the 'technical lineage' (*« lignée technique »*).[733] Each 'technical lineage' encases a particular chain of technical developments, in which a technical object passes through a succession of technical 'stages' (**Fig. 47**).

The basic idea – although often spelled out rather vaguely – seems to be that 'technical lineages' host a multitude of different and temporally dispersed technical objects sharing a basic set of relevant techno-functional principles (cf. Boëda 2013: 49f.).[734] Thus, the conception appears to be that 'technical lineages' organise aspects of the observable 'structural' and 'operational' variability of lithic objects to the point that the *genesis* (the 'becoming-concrete') of a 'functional' schematic becomes discernible – a schematic that ultimately unifies all the different objects.[735] The dynamic evolution of aspects of 'structure' (*structure*) and 'operation' (*fonctionnement*) is thus rendered intelligible by illuminating their role in the emergence of a relatively stable and well-defined 'function' (*fonction*). The implication is that the ultimate finalities (*fonctions*) of lithic objects – whether they are tool-systems or even larger technical systems – can only be assessed if the corresponding 'technical lineage' is identified and analysed. Techno-genetic reasoning is 'synthetic' in this sense – technical objects can only be understood if placed into their 'significant' evolutionary wholes, that is, into their respective 'technical lineages' (*« lignées techniques »*).

With Pepper, we can clarify the organicistic status of this style of reasoning. To this end, it is useful to distinguish between 'primary' and 'secondary' technical contexts: 'secondary' technical con-

---

[730] An alternative label for the same research enterprise is 'techno-morpho-functional' inquiry (*étude techno-morpho-fonctionelle*).

[731] See e.g. Soriano (2000: 6-8) for a summary of what is seen as the core difficulty of lithic use-wear analysis and why it is regarded to be of limited value in pre-Upper Palaeolithic contexts of technicity. See also Lepot (1992/1993: 134), Jaubert (1999: 57f.), and Boëda (1997: 107, 2005: 48, 2013: 29): "[...] [t]he arguments are to be derived from the coherence of the technical system by means of the techno-functional approach and not by means of traceological analysis which merely confirms the presence of hafting, without informing us of its specificities." (Boëda 2013: 229; my translation [the original French quote is provided in **Appendix Q.22**]).

[732] The differentiation between 'structure,' 'operation,' and 'function' broadly corresponds to Rabardel's (1995) distinction between 'artefact', 'scheme of utilisation,' and 'instrument' on which Boëda (2013: 50-55) and his students draw (e.g., Soriano 2000: 119, 134).

[733] The concept of the 'technical lineage' has been proposed by Simondon (1958) and further developed by Deforge (1985). See also Tinland (1977), Stiegler (2004a), and Guchet (2008). For a summary of its core meaning and a discussion of its role in Palaeolithic research, see Chevrier (2012: 100f., 111-113).

[734] The notion of the 'technical lineage' embodies the 'organicistic' preoccupation with the tension between unity and diversity. In Palaeolithic research, the concept is typically defined as a *structural family-resemblance* – different objects of the same family of lithic structures are analysed in their becoming (cf. Chevrier 2012: 157). The 'technical lineage' is thereby the *unifier* and the aim is to show that at least a part of the natural diversity of technical objects can be resolved by invoking the concept (see next footnote).

[735] We may say that the identification of a basic functional scheme through the analysis of 'technical lineages' plays a somewhat similar role as, say, the identification of the *schéma opératoire* in the analysis of lithic assemblages. Moreover, the examination of the latter typically provides critical clues about the former. The spatiotemporal organisation of lithic assemblages and situated technical systems simply represent a 'stigma' of the 'technical lineage' they are a product of. In the same sense as *chaînes opératoires* specify the status of each lithic artefact in a given lithic assemblage, 'technical lineages' specify the status of each *chaîne opératoire* in its attendant evolutionary chain. We may say that the 'ontogeny' of a lithic technical system is informative about its relative 'phylogenetic' position. However, this assertion does not imply that 'technical ontogeny recapitulates techno-functional phylogeny,' but merely underscores the fact that each technical system is a result of its past and points to its future.

texts are lithic assemblages, technical systems, tool-systems, and/or a combination of them all; 'primary' technical contexts are the 'technical lineages' in which the 'secondary' technical contexts make their appearance. One can then say, first, that the 'primary' context *dynamises* the associated 'secondary' contexts on the temporal plane and, secondly, that the totality of 'secondary' contexts defines the set of 'progressive' categories individualising the 'primary' context, which therefore embodies the 'ideal' categories of the total temporal whole.

The evolution of lithic objects, in this view, is determined by the 'dialectical' movement between the 'primary' context and its 'secondary' contexts and consists in the 'progressive' movement towards the 'ideal.' The divergent character of the 'secondary' contexts make clear that lithic evolution is a 'staged' process and that evolutionary time can be differentiated only qualitatively, not quantitatively.[736] The organic process that 'progressively' leads to the 'primary' context is initially 'concealed' since what is given in experience are only isolated 'secondary' contexts. The 'secondary' contexts come thereby into view as 'fragments of reality' and their succession, although initially 'concealed,' turns out to be directed and irreversible. All 'contradictions' and/or 'conflicts' between the 'secondary' contexts are resolved by unifying them through their 'primary' context.

The resulting research mandate seeks to identify 'primary' contexts and to determine which 'secondary' contexts *belong to them*. The overall goal of lithic inquiry is thus to detect the nature of the organic process that arranges the 'secondary' contexts in time and gives shape to the 'progressive' categories that lead to the 'ideal.' It remains an empirical question to specify which evolutionary mechanisms, principles of development, and/or phylogenetic laws can be said to underpin this organic process. This endeavour typically comes down to determining the *logic of change* between the developmental stages and to assess whether or not this logic changes through time (that is, whether other stage-transitions in the same whole conform to the same logic). Conceptually, interpretations juxtapose the evolutionary fact of 'techno-genesis' (*« techno-genèse »*) with the 'techno-logic' (*« techno-logique »*)[737] of lithic development (cf. Boëda 2013: 87f.). It should be clear that this strategy generally predisposes techno-genetic inquiry to spawn *qualitative* accounts of lithic evolution – it is simply unclear how one would study the 'logic of change' in purely quantitative terms.

As already indicated before, organicistic conceptions of evolution are by no means new in the French scene but have already played an important role in the 'ancestral' and 'formative' periods of Palaeolithic research. Garbiel de Mortillet, Pierre Teilhard de Chardin, and the 'Early' André Leroi-Gourhan, for example, remain exemplary cases of theorising the grand scheme of technical evolution, while Henri Breuil can be mentioned as a model case of interpreting the development of Palaeolithic art from an organicistic perspective. Mortillet coined the term 'palaeoethnology' (*« paléoethnologie »*) – not to be confused with the *« Palethnologie »* developed by the 'Later' Leroi-Gourhan and his team – to denote an integrated 'new science of prehistoric man'[738] and subdivided the Palaeolithic period into several 'ages' – from the Acheulean to the Tourassian (today's Azilian). These 'ages' were considered 'stages' of a directed evolutionary sequence. For Mortillet, as subsequently for Leroi-Gourhan, the Palaeolithic constitutes an indisputable part of human history (cf. Junghans 2014 [1987]: 47) – an important window into *« histoire générale »* ('general history') or what Marc Bloch later termed *« histoire totale »*.

Mortillet's long-term history was already a history of alternating 'civilisations' (*ibid.*: 54). Yet, the basic organicistic idea, namely that human history can only be understood as a continuous but

[736] The fact that time, if one resists its 'spatialisation,' can only be differentiated qualitatively was also a main conclusion of Bergson's *Évolution créatrice* (1907; cf. Copleston 1994 [1974]: 186). With Pepper, we can add that the 'spatialisation' of time results in the conception of a 'field of temporal location' typically tied to an 'objectivist' account of time stressing its homogeneity. This account corresponds to the classic 'mechanistic' reading of time and thus signifies an important locus of divergence between 'mechanism' and 'organicism.'

[737] 'Techno-logic' (*« techno-logique »*) is a difficult concept and regularly, I believe, confused with other affiliated terms. The term for example needs to be distinguished from the notion of 'technical logic' (*« logique technique »*) which seems to be a category of 'contextualism.' This 'technical logic' captures the organisational, that is, 'infrastructural' logic of technical contexts, i.e., technical systems, periods, or sub-periods. 'Techno-logic,' by contrast, appears to target the structural organisation of an organic temporal whole, conveying especially the nature of the various 'stage-transitions' that can be observed as the whole unfolds. Both concepts therefore pinpoint relational configurations of 'significant' wholes: 'technical logic' pictures the relational configuration of contexts – the wholes of 'contextualism' – and 'techno-logic' portrays the relational configuration of organic structures – the wholes of 'organicism.' The concept of 'techno-logic,' proper to an organicistic interpretation of technological evolution, thereby reproduces the indubitable *topos* of 'unity in diversity' – it expresses the belief that different developmental stages can be unified through a common principle of becoming.

[738] Cf. Junghans (2014 [1987]: 53f.).

creative movement of 'man' and 'matter' giving rise to successive stages of lithic development, was perhaps carried to the extreme in the writings of Teilhard de Chardin (1955, 1956; cf. Schiwy 2006).[739]

It was the 'Early' Leroi-Gourhan, however, who set the lasting agenda for French techno-organic reasoning.[740] His distinction between *« faits »* ('facts') and *« tendance »* ('tendency') – already alluded to in the last section – holds the key for understanding the recent return to the roots of lithic organicism in the French scene (cf. Boëda 2013: 23). For Leroi-Gourhan, *« fait »* was a means of expressing that the same global tendencies of technical development can be tangibly instantiated in a number of different ways; each society typically supports its unique instantiation(s) of technicity. This conception was considered to offer a solution to the undeniable fact that there is much technical variability even though technical evolution appears to be directed.[741] Arguably, Leroi-Gourhan never fully abandoned the distinction between 'facts' and 'tendency' but relocated his attention in the course of his career. While the 'Early' Leroi-Gourhan of *Évolution et techniques* was preoccupied with the grand narratives and, as a consequence, focussed on the 'tendencies' of technical evolution, the 'Later' Leroi-Gourhan, branded by the Pincevent experience, prioritised studying the situated facts (*« faits »*) of particular sociocultural contexts.[742]

From this perspective, the tension between 'facts' and 'tendency' motivates a distinction between 'evolution' and 'history' (cf. Boëda 2013: 231). 'History' becomes a category proper to distinct evolutionary 'stages'; it can be taken to describe those aspects of lithic technical variability which are unnecessary for effectuating the transition to the next 'stage.' History, if you will, is then the creative variation of a necessary theme. 'Evolution,' for this reason, comes into view as a process that transcends historical contingency and is 'transcultural' in a fundamental sense (*ibid.*: 23, 223-236). The distinction between historical and evolutionary factors therefore turns out to be an empirical precondition for techno-genetic reconstructions. Methodologically, the characterisation of a 'technical lineage' – which presupposes the identification of the latter's effective evolutionary features – should therefore enable the discrimination between cultural and non-cultural variation in the associated lithic technologies (*ibid.*: 146, 167).[743] This interpretive dichotomy between 'history' and 'evolution' seems to be another important discriminator between the 'techno-genetic approach' and *« Paléohistoire » sensu stricto*, which does not discriminate between these two concepts.

For techno-genetic approaches, history and evolution represent different games that are played with different rules on different temporal scales. If *« Paléohistoire »* can be described as a practice of 'hyper-history' (cf. Valentin 2011), 'techno-genesis' (*« techno-genèse »*) would be concerned with 'hyper-evolution.' Strictly speaking, the latter's main concern lies not with the *longue durée*, but with the *très longue durée*. What it shares with *« Paléohistoire »*, however, is the 'dendritic paradigm.' Yet, this is also where it voices some quiet critique on Leroi-Gourhan. Techno-genetic research is based on the recognition that there is not only a single global technical 'tendency' but instead multiple local 'tendencies.' The reasons for this are manifold: for one thing, each 'lineage' develops in its proper 'natural milieu'; for another thing, contingent developments and random factors (including rare events) at an early stage of a 'lineage' may have irreversible and *direction-giving* effects on the evolutionary trajectory of the 'lineage' as a whole – technical lineages are *path-dependent* to this effect. Because a given lineage can be called 'cultural' only in this twofold sense – or, alternatively, because it differs from other 'lineages'[744] – techno-genetic accounts tend to be techno-deterministic. The space of cultural variation is preconfigured by larger technical trajectories, some of which may leave little leeway for lithic cultural variation:

[739] Boëda (2013: footnote 20 [35]) explicitly invokes Teilhard de Chardin as an ideational forefather.
[740] The key role of Leroi-Gourhan is also acknowledged by Boëda (2013: 28).
[741] Leroi-Gourhan's 'tendency' (*tendance*) represents an appropriation of Bergson's « *élan vital* » (cf. Gazagnadou 2008: 46). For the many 'Bergsonisms' in the work of Leroi-Gourhan, see Schlanger (2004, 2015). For the role of the concept in lithic techno-genetic research, see esp. Boëda (2013: 35, 223).
[742] From this perspective, Leroi-Gourhan's *Le geste et la parole* (1964/1965) amounts a transitory work. The passage from the 'Early' to the 'Late' Leroi-Gourhan may in fact correspond to a research-historical transition from an initial 'organicistic' orientation of inquiry towards a full-blown 'contextualistic' inclination. In retrospect, we can say that this 'Late-contextualistic' Leroi-Gourhan was born in Pincevent. Clearly, however, more historical groundwork is needed to confirm this affirmation.
[743] *Contra* 'mechanism,' the contention here is that the discrimination between 'functional' and 'non-functional' factors in relation to a given temporal present is always short-sighted. 'Non-functional' factors can only be identified if the evolutionary function of effectuating change in a given direction has already been excluded.
[744] The plurality of possible technical 'lineages' delivers only an indirect argument for the 'cultural load' of these lineages. This problem, however, is openly acknowledged and has motivated the discussion of technical convergence in an 'organicistic' context of inquiry (cf. Boëda 2005).

> "[…] [I]n the case of 'Type Pyramidal E2,' several methods permit to produce uniquely blades or, contrarily, a mixed technique may deliver triangular blade removals including Levallois points. In the case of the [D]iscoid as of the pyramidal, however, the direction of detachments has no value in differentiating the methods. In the case of the [D]iscoid, it is effectively necessary to change the direction of removal in order to proceed from a first exploitable volume to a second one; in the case of the pyramidal, it is necessary to obtain detachments from the same direction. In opposition to what we will see for the Levallois core and certain Upper Palaeolithic cores, changing or uniform directionalities represent more a structural necessity than the expression of a cultural character." (Boëda 2013: 146; my translation [the original French quote is provided in **Appendix Q.22**])

Another reason for the plurality of technical trajectories is that technical 'tendencies' – Boëda's *« lignées »* – may be *object-specific* (Boëda 1997, 2005, 2013). This potential object-specificity of technical trajectories marks the input of a second key source of techno-genetic thought – French philosophy of technology and its cybernetic heritage. Boëda (2005, 2013) and his students (e.g., Nicoud 2011; Chevrier 2012; Rocca 2013) specifically draw on the work of Gilbert Simondon, one of the most influential technologists of 20th century France. His central text is *Du mode d'existence des objets techniques* (1958). This work, which is foremost *technological* and only secondarily anthropological (Barthélémy 2015), suggests that technical evolution can only be properly understood by examining the genesis of technical objects – their 'becoming' (Simondon 1958: 19f.); Simondon considers the evolution of technology to be guided by *structural laws proper to the technical domain*. Accordingly, technical objects possess a specific 'mode of existence' (cf. Boëda 2013: 28, 88; Nicoud 2013: 51). Technology is viewed as a 'quasi-living' force capable of self-regulation and evolutionary self-determination. How this general capacity is realised, however, always depends on the technical object in question:

> "Technique, just like magic or religion, is a way of being in the world. Th[e] cultural evaluation of technical reality entails the investigation of the technical nature of an object, rethinking the object from the perspective of its technicality and reconsidering the technical object as structurally coupled with the human, itself becoming. This notion of coupling necessarily implies a co-evolution of human[s] and technique[s], the latter being governed by 'laws of evolution.'" (Boëda 2013: 28; my translation [the original French quote is provided in **Appendix Q.22**])

Following Simondon (1958, 2014), a technical lineage fulfils the functional potential of a technical object as the object passes through time, typically by increasing the latter's internal 'inclusiveness' and/or 'organicity' in such a way that the object's functionality is optimised – each systemic element then implies any other element and only all elements together ensure the total functionality of the object (cf. Simondon 1958: 50-55). The functional potential that is thereby carried through by a technical lineage is called 'technical essence' (Simondon 1958: 41f.). This 'technical essence' describes the 'ideal' of a technical lineage in light of its 'progressive' categories (see *supra*); it corresponds to the already introduced notion of a 'functional schematic' holding a technical lineage together in time. The continuous re-adjustment between a 'technical essence' and the lineage that lives up to this essence generates the 'laws of evolution' proper to the lineage.

Boëda (1997, 2013: 40) adopts Simondon's (1958: 19-22) ideal-typical distinction between 'abstract' technical objects (*« objets abstraits »*) and 'concrete' technical objects (*« objets concrèts »*) to develop a new perspective on how lithic technology evolves. Discriminating between the two establishes a spectrum of developmental stages from the relative starting point of a technical lineage to its relative endpoint (*ibid.*: 23-49, 61-64). This spectrum is thought to deliver a universally-valid scheme of technical development which, in turn, can be used to assess the relative position of lithic objects in their evolutionary chain(s).[745]

'Abstract' stages describe a condition in which the contribution of each technical part (if any) to the overall functionality of the technical whole is *independent* of other parts – 'abstract' technical stages harbour compartementalised systemic entities. 'Concrete' stages, by contrast, can be characterised by a condition in which the parts are *interdependent* and *only in concert* produce the functionality of the whole – the contribution of each part has become inseparable from the contribution of all other

[745] Again, it has to be emphasised that 'universality' is only granted to the general progression from more 'abstract' to more 'concrete.' Which stages are taken, which are perhaps skipped, and how the stages are precisely instantiated, is an empirical question and potentially differs between various object-matters. We may thus more properly speak of a *general developmental frame of reference* rather than a universal scheme (cf. Chevrier 2012: 103f.).

parts. In this second case, the parts can be said to form an integrated 'organic whole' while in the first case their 'being-one' ('one-ness') is implicated but not (yet) realised. In order to identify a technical lineage and by means of this lineage explain all objects found in it, one needs to show that the actual (ideally: observed) temporal enchainment of objects can be rendered intelligible as a succession of ever more 'concrete' systemic entities.

Simondon (1958, 1964, 1989) names this passage from the relatively 'abstract' to the relatively 'concrete' a process of *concretisation* or *individuation*. One can speak of 'individuation' because evolving objects, by becoming more and more 'concrete,' literally *find to themselves* – to their 'technical essence.' Technical evolution comes into view as a process of self-identification and, perhaps more importantly, *self-adaptation* (Simondon 1958: 50-55).[746] Technical objects, if you will, transition from a state of inner 'schizophrenia' to a state of internal indifference (cf. Boëda 2013: 40).[747] To overcome the schizophrenic state of organisation means to realise the technical 'ideal.' Again, technical evolution is regarded to be inherently *creative* because its organic processes have to resolve the *tension* [*Spannung*] between the parts of a (yet) 'un-concrete' whole (cf. Schick 2013: 153).[748] Creativity, then, is defined as the evolutionary fact of resolving technical 'conflict,' which presupposes developmental potentiality rather than predetermination.

The categories of 'abstract' and 'concrete' are logical refinements of the 'ideal' category of the 'organic structural whole': 'concrete-ness' refers to completely realised 'organicity,' whereas 'abstract-ness' specifies the exact opposite – a state of 'in-organicity.' The two notions are purely theoretical; they open a space of developmental potential to proceed from 'abstract' to 'concrete' wholes. The latter state is rarely reached in reality because achieving the 'ideal' would imply eternity and the end of evolution (cf. **Appendix II.2**). Even though the realisation of the 'ideal' is somewhat paradoxical, it does offer an explanation for why technical lineages may collapse *sui generis*: fully realised organicity typically implies *evolutionary inflexibility* since the re-organisation of parts, without sacrificing key functionalities, becomes practically impossible. The inability of an 'ideal' system to adapt to novel circumstances therefore *enables* a new technical lineage to emerge (cf. Boëda 2013: esp. 230-236). This is the organicistic interpretation of lineage extinction and/or succession. This perspective underlines 'cyclicity' (sub-cycles, cycles, epi-cycles) as a key feature of technical evolution.

The focus on categories implied by the 'ideal' leaves the 'progressive' categories of technical evolution largely undefined. According to organicism, this should be seen as an advantage since it is consistent with the idea that wholes set the evolutionary tone and parts are instantiated by the necessity to realise them. The 'progressive' categories are therefore whole-specific and have to be determined empirically. This is where typology comes into play. 'Effective' types – typically identified with what has been coined *techno-functional types* – are considered to instantiate the 'progressive' categories of their wholes. The role of typology is to facilitate the detection of technical objects that belong to a given technical lineage and to somehow encapsulate the arguments for attributing the respective objects to the lineage. The result is a sharp distinction between 'effective' and 'ineffective' lithic types – the former help to chart technical lineages, the latter only cloud the view for them.[749] Based on the aforemen-

---

[746] Simondon (1958) sometimes also invokes terms such as *auto-correlation* or *self-convergence* because 'individuation'/ 'concretisation' amounts to a 'structural' and 'operational' match between the parts of a whole that ensures the latter's global functionality.

[747] The tendency of technology *to adapt its parts to itself* provides a general evolutionary mechanism to explain technical becoming (Boëda 2013: 40). The concept of 'self-adaptation' thereby implies a new interest in *synergetic relations* – a key *topos* of French technological research in general. The interpretive manoeuvre in techno-genetic research is to re-direct the attention to *system-internal synergies* instead of mainly concentrating on the complementarities between distinct yet co-occurring technical systems (i.e., between *débitage* and *façonnage* systems). An important consequence is that Darwinian adaptation becomes a secondary phenomenon at best.

[748] Conversely, if there is no tension or structural conflict, the evolutionary 'impulse' is dramatically reduced. At the extreme, there is no evolution at all because there is no 'abstract-ness' left. This implies that full-blown organicity – the 'ideal' – may mark the end of evolution and typically ushers in a state of developmental stasis or collapse. The 'saturation' of an evolutionary lineage – its complete 'concretisation' – is therefore likely to be the beginning of the end of this lineage. It is in this sense that 'organicists' may speak of the natural 'death' of technical linages.

[749] The distinction between 'effective' and 'ineffective' lithic types is a consequence of the inherent 'integrativity' of 'organicistic' explanation. Since 'organicism' presupposes a relatively high degree of worldly order and because determination is considered to be 'focused,' some facts turn out to be irrelevant and can even be thrown into the 'unreal.' This general inclination engenders a core difference to 'contextualistic' practices of lithic typology. As shown in the last part of this chapter, 'contextualism' tends to pluralise typology in order to capture different levels of typological organisation; these levels of typological variability are later related to one another in order to clear the view for the verticalities and horizontalities of technical 'infrastructure' – the strategy is inclusive and 'dispersive.' In 'organicism,' by contrast, some typologies – those which fail to help illuminate their temporal wholes – are simply discarded. They are identified as 'deceptions of appearance.' This basic difference explains why lithic 'organ-

tioned, it becomes then clear that 'effective' types must take into consideration the 'structure' of lithic technical objects, rather than their form (cf. Forestier 2000: 544).[750]

The classificatory systems developed by proponents of the techno-genetic approach reflect this realisation (cf. e.g., Soriano 2000; Forestier 2010; Chevrier 2012; Boëda and Hou 2011; Nicoud 2011, 2013; Rocca 2013; Nicoud et al. 2016; Chevrier et al. 2017). Classifications are guided by the objective to identify different part-configurations and the relationships between the lithic parts and their technical whole. We can distinguish between two complementary approaches to characterise these 'technical structures' and to examine the associated processes of systemic integration: the first is centred on the analysis of *tool structure* (Boëda 2013: 54f.), the second on the evaluation of *structures of volumetric core exploitation* (*ibid*.: 89-97). The general interpretive categories developed by these two angles of investigation furnish the principal resources to devise the 'progressive' categories required to chart the evolution of lithic systems from their 'abstract' to 'concrete' states. The fact that these categories appear to be case-sensitive – especially that they fundamentally differ when reduction-systems and tool-systems are compared (cf. *ibid*.: 28, 88) – underscores the organicistic pre-occupation with object-specificities.[751]

The first strand of techno-functional inquiry, taking into account the evolutionary becoming of tool-systems, is based on the identification of *techno-functional units*, or *UTFs* (*Unités techno-fonctionnelles*) in French (cf. Boëda 1997: 107, 2001, 2013: 39, 54f.; Soriano 2000: 123f.). The methodological and interpretive resources to analyse UTFs (henceforth 'UTF-analysis') have been developed collaboratively, even though Michel Lepot's (1992/1993) *théorie artisanale de l'outil* ('non-industrial theory of lithic tool production') was a key contribution. Lepot (*idem*) developed a basic toolkit to characterise the functional parts of lithic tools in order to compare their organisational structure (cf. Boëda 1997: 107-109; **Fig. 48**). The examination of a tool-system's UTF-structure is generally based on the morpho-technical character of the modified and non-modified edges, their chronological and topological relationships, and their contribution to the total functional design of the system (cf. Pagli 2009; Bonilauri 2010; Forestier 2010; Donnart 2010; Lourdeau 2010; Bodin 2011; Chevrier 2012).

In contrast to traditional wear studies, UTF-analysis pays primary attention to the *potentialities* of tool-use rather than empirically attested tool functions (if any); it explores the functional 'efficacy' (*efficacité*) of making tools in particular ways (cf. Lepot 1992/1993: 119). The basic idea is that not every edge configuration can serve every possible tool-function (e.g., Lepot 1992/1993: 26-88, Planche 4-23; Soriano 2000: 119-135, Annexe 2 [411-416]). Specific tool-functions impose specific functional requirements on the tool-edges supporting them. One can therefore study the 'functional morphology' of tool-edges in order to isolate aspects of the original 'functional intention' motivating their creation. The general conception is that 'a tool exists only in action' (*sensu* Leroi-Gourhan 1964/1965, 1968) and is always adapted to a specific tool-aided gesture (cf. Boëda 2013: 46).[752] Moreover, a tool-system's past (process of manufacture) can be said to have led to its present (current state of structural organisation), only to point to the tool's future (possible usage). There is thus an inseparable link between the

icists' tend to be much more hostile against 'Bordian' and other classic types than 'contextualists' (cf. e.g. the recurrent critique on 'typology' by Boëda). The key difference to 'mechanistic' typologies has to do with the 'synthetic' nature of types in 'organicism.' In opposition to 'mechanism,' in which lithic types are also treated 'integratively,' 'organicistic' types are rendered 'effective' through the specificity of their relationship with organic wholes, their epistemic 'effectiveness' only *indirectly* relies on other types/parts.

750 The reliance on structure-based types is perhaps the main reason why lithic 'organicists' do not come to grips with 'formists,' who base their types on patterns of part-driven forms, often paying exclusive attention to shape-based artefact attributes.

751 The fact that the progression from more 'abstract' to more 'concrete' developmental stages is regarded to instantiate itself in a myriad of different ways generally reveals how 'organicism' interprets the 'operationalisation' of general theory. If Simondon (1958) provides a general theory of technical becoming, Boëda (1997, 2005, 2013) is concerned with how the categories of this theory (relative 'abstract-ness' vs. relative 'concrete-ness') are to be interpreted in different lithic domains. This application of general theoretical categories to object-specific, empirically explorable domains conforms to the 'operationalisation' of these categories. This may indicate a fundamental difference between 'organicism' and 'mechanism' since the former – as we have seen – seeks to translate general categories into object-specific categories whereas the latter typically translates general categories into quantifiable and testable categories (these are object-specific only insofar as the tested features and feature-constellations must of course be measurable). 'Operationalisation' is therefore unequally interpreted, reminding us of the strong conceptual tension between 'organicism' and 'mechanism.'

752 The insight that tools are crystallisations of human gestures, again, refers back to Haudricourt (1987) who maintained that tools can be defined as *adaptations to human gestures* (« L'outil est adapté au geste et non inversement »; cit. Haudricourt 1987: 158). For a similar contention, see Leroi-Gourhan (1968).

production, structure, and function of a lithic tool – a link that can be explored and studied (cf. Nicoud 2013: 45).

The functional potential of lithic tools may be analysed on two levels. First, each edge configuration generates its own 'nexus' of possible instrumentalisations (if any). Second, each tool-system as a whole also creates its 'nexus' of possible instrumentalisations (if any), but this 'nexus' is determined by the meeting point(s) (if any) of all or some of the 'nexuses' of its effective functional parts. Differentiating between these two levels motivates to distinguish between 'tools' (*outils*) and 'artefacts' (*artefacts*) for the two may not be identical (e.g., Chevrier 2012: 135-138).[753]

Although the distinction between 'artefacts' and 'tools' is often confused, the basic idea seems to be that the former should be regarded as material placeholders for the latter and, depending on the tool-system in question, may accommodate either a single 'tool' or multiple 'tools.' In the latter case, each artefact-edge with functional potential may constitute a 'tool' of its own – the artefact itself then represents a 'pluri-tool' (*sensu* Boëda 2013: 63-64, Fig. 16, 19, 20; cf. Chevrier 2012: 265-275; **Fig. 49**). Alternatively, all artefact-edges with functional potential are integrated into a single 'tool' – we may then speak of 'mono-tools,' 'true tools,' or proper 'artefact-tool identities' (cf. Boëda 2013: 63-64, Fig. 17, 18; Nicoud 2013: 48f., Fig. 3B; **Fig. 50**).[754] This strategy is clearly organicistic. The resultant categories serve to delineate relatively 'abstract' from relatively 'concrete' tool-states: 'pluri-tools' are defined as non-organic entities – the functional 'nexuses' of all relevant artefact-edges are difficult to coordinate; 'true tools,' by contrast, are defined as highly inclusive entities whose functional parts have been successfully coordinated – they embody a functional equilibrium of the 'nexuses' of their parts.

The routinely employed distinction between the 'transformative' part of a tool-system (*partie transformative/coupe de CT*), its 'prehensive' part (*partie préhensive/coupe de CP*), and its 'transmissive' part (*partie transmettrice/coupe de CR*) (Boëda 1997: 107-110, 2013: 54-55, Fig. 11; cf. Chevrier 2012: 147; **Fig. 51**)[755] hence establishes a classification of tool-areas based on the coordination (and/or non-coordination) of the 'nexuses' of all relevant technical elements, especially the edges, of the system in question. This classification takes into account that not every potential tool-edge, whether modified or unmodified, necessarily serves as a 'cutting-edge' in the tool-system. Different edge-treatments may signal the differential *status* of artefact-edges and the artefact-parts they belong to.

The tripartite differentiation between CTs, CPs, and CRs thus aims to illuminate the 'function' (*fonction*) of varying tool-parts in bringing forth the 'structure' (*structure*) and 'operation' (*fonctionnement*) of a tool-whole. CTs signify the 'active' tool-parts (proper cutting-edges), the areas where the tool is designed to come into direct physical contact with the worked material; CPs denominate the 'passive' tool-parts ('false' cutting-edges) which primarily serve to received and/or absorb the energy of utilisation – 'passive' parts may also define the ergonomic qualities and the grip characteristics of the tool-system; CRs, finally, facilitate the flow and transformation of energy between the 'active' and 'passive' tool-parts – their role is 'mediative.' Each tool-system may harbour multiple UTFs of each type

---

[753] The distinction between 'artefacts' and 'tools'/'instruments' is also propagated by Rabardel's (1995) theory of tool-use.

[754] Nicoud's (2011, 2013) doctoral research on the evolution of bifacial technology in the Western European Acheulean can be cited as an example for the identification of 'integrated' and 'disintegrated' schemes of tool construction. Nicoud (2011: esp. Fig. 126) distinguishes between three types of bifacial configuration: (i) 'false bifaces' which turn out to be bifacially exploited core-matrices (*galets à enlèvements bifaciaux*), (ii) 'bifacial blanks' which serve as tool-matrices for future modification (*pièces bifaciales supports d'outil(s)*), and (iii) 'true bifaces' which represent the only truely integrated bifacial tools (*pièces bifaciales-outil*) (cf. Nicoud 2013: 45-51, Fig. 3). Two aspects of this scheme are of particular importance: first, the author shows that some artefacts only 'appear to be' bifaces, but after close inspection turn out to be bifacially-worked cores – they represent an 'ineffective' category which has to be (at least partly) explained away; secondly, the distinction between 'bifacial blanks' and 'true bifaces' is based on an analysis of artefact-tool relations from the perspective of the latter's becoming (sequencing of the manufacturing process). The difference between the two is that in case ii the construction of the bifacial volume is independent of (and in fact precedes) the construction of active tool-edges, whereas in case iii both are formatively intertwined. While the generated bifacial volume of ii – literally a 'bifacial-blank' – may support a number of different tool-edges, the construction of the volume in iii anticipates the global tool-functionality. The former hence represents a 'disintegrated' tool-system, the latter an 'integrated' one. Noteworthy is especially that technical 'integration' and 'disintegration' are conceptualised in *temporal* terms and that the determinative effects of creating either the artefact or the tool(s) are considered. 'Bifacial blanks' simply represent an object category in which the 'nexus' of the artefact is not coordinated with the 'nexus' of its future tool-edges – the artefact determines its 'tool-ness' rather loosely. 'True bifaces,' by comparison, exhibit a high level of coordination between the 'nexus' of the artefact and the 'nexus' of the future tool(s) – the construction of the artefacts determines the future tool-state fairly well. Nicoud's approach demonstrates that interpretive categories are based on a consideration of how past, present, and future interpenetrate each other in within a given technical object.

[755] Lepot (1992/1993) originally proposed a slightly different terminology. He (*ibid.* : 123) differentiated between *« contact transformatif » (CT)* ('transformative part'), *« contact préhensif de l'outil » (CP)* ('prehensive part'), and *« contact réceptif de l'énergie » (CR)* ('transmissive part').

(not all types need to be represented though) and each type may be instantiated in a number of different ways.[756]

The point is that the intentional modification of an edge cannot – *by default* – be taken to imply its 'active' role as primary cutting-edge. Similar types of modification may contribute differently to the 'operation' of dissimilar tool-system; their function may vary due to disparate structural tool-configurations (cf. Chevrier 2012: 135f.), reflecting the classic organicistic interpretation of 'equifinality' – that similar forms or partial configurations may be instantiated by varying structural wholes (**Fig. 52**).

The determination of the functional techno-morphology of potential tool edges and non-tool edges relies on the meticulous description of retouch types (i.e., marginal, scalariform, denticulated), edge morphologies and cross-sections, relationships between the intersecting surfaces creating the edges (i.e., plano-convexity, semi-convexity, biconvexity, etc.), and the angulation of edges, including the characterisation of edge outline and 'route' (**Fig. 53**). In general, the assessment relies on a *lecture* of the present micro- and macro-detachments and their technical, spatial, and chronological relationships. This approach is firmly rooted in the core principles of *chaîne opératoire* analysis (cf. Lepot 1992/1993: 26-88; Bourguignon 1997; Soriano 2000; Nicoud 2011; Rocca 2013), including the reconstruction and evaluation of *schémas diacritiques* (cf. Soriano 2000: 119-135, Annexe 2 [411-416]).[757] Analogously to studying the 'technological morphology' of lithic artefacts (*sensu* Tixier 2012 [1978]: 125-132), the goal is to establish the 'functional morphology' of lithic tools and tool-systems (cf. Boëda and Hou 2011).

This 'functional morphology' not only seeks to convey the functional potential of particular edge-configurations, but also takes into account how these edges are *situated* in the tool-system, for instance whether they possess an opposing 'non-active' edge shaped in a different manner, exhibiting a natural/artificial back or not.[758] Ultimately, all of these relational aspects serve as 'fragments' of a functional tool-reality – they need to be resolved in their systemic totality. Each 'fragment' is compared to its appendant 'fragments' in order to evaluate whether or not the respective 'nexuses' meet – the presence of certain tool-functionalities can thus be reconstructed as a successful meeting of 'nexuses.' Moreover, the resulting configurations of positively resonating 'nexuses' of tool-parts provide a baseline for isolating the *ergonomic* and *energetic affordances* a tool-system provides.[759] The totality of these functional affordances, in turn, can be interpreted to reflect *how tool-systems are adapted to their utilisation*. The functional potentiality of tools and tool-systems is thereby thought to imply a crystallised human gesture.[760]

In this way, the relative 'integration' or 'disintegration' of various UTFs and their 'functional pregnancy' can be taken as a measure for the relative 'abstract-ness' or 'concrete-ness' of lithic tool-systems. This, in turn, allows researchers to discuss whether the functional potential of particular tool structures has been exhausted or whether there is potential for refinement and optimising change (e.g., Nicoud 2011: 400-403, esp. fig. 131; Chevrier 2012: 725-733; Rocca 2013: Chapitre XIII; Moncel et al. 2016a, 2016b, 2016c; **Fig. 54, 55**). The identified tool-structures – interpreted as a *functional present* – are therefore used to *project* their possible further-developed instantiations into the future.

---

[756] The lack of a major UTF-type may be taken as positive evidence. An example is the apparent lack of an *UTF de CP* ('prehensive part') which may signal that a tool-system was originally hafted, that is, has been part of a more complex super-system involving organic elements (cf. Boëda 2013: 73-75). Again, the lack of a particular UTF-type is seen to change the configuration of 'nexuses' and, as a consequence, to disclose the *potentiality* for hafting. One may even argue that in order to respect the system's global 'operation' (*fonctionnement*), one has to infer that the tool-system *was*, in fact, hafted. This would be an argument from necessity which depends in its validity entirely on the global articulation of the 'effective' tool-parts.

[757] For a discussion of *chaîne opératoire* analysis and its key operations, see the last part of this chapter.

[758] This holistic interpretation of edge-configurations provides new meaning to long-standing lithic tool concepts such as a 'knife.' It may also shed new light on the question of whether or not particular tool-edges can be said to be more versatile or more specialised than others. While some edges, as we have seen, may be not functional at all (i.e., due to their extreme biconvexity), some may be 'razor-like' (i.e., due to their relatively flat plano-convexity) and some may be 'saw-like' (i.e., due to their denticulated step retouch). These and other differences pave the ground for new ways of classifying tools and their parts. This mode of classification highlights 'integration' and the contribution of features to the 'organic' functioning of their whole(s).

[759] For an explanation and discussion of the concept of 'technical affordances,' see the last part of this chapter.

[760] It should be emphasised that the interpretation of functional potentialities is generally *independent* from the question of whether or not these potentialities have actually been *realised* by past users or not. UTF-analysis does not necessarily assume that these past users have *always* exploited the full functional potential of their tools. It typically does assume, however, that the functional potential of tools is *inseparable from how tools had to be conceptualised* before they were created. Strictly speaking, not even this assumption is necessary since particular tool-manufacturing decisions may lead to unanticipated functional potentials which may drive the long-term evolution of these tools yet not always impact their actual utilisation at a given point in time.

Insights on the potentials for refinement and optimising change helps to connect particular tool-instantiations with other tools succeeding them in time. If no absolute chronology is available, tool-structures can be ordered in such a way that maximally parsimonious – that is, *coherent* – technical trajectories are retrievable;[761] this provides an indirect measure of the relative chronology of different tool-instantiations belonging to the same technical trajectory.[762]

The second strand of techno-functional inquiry, addressing the issue of the functional integration of lithic blank production structures in technical evolution, examines the differential treatment of core-matrices in order to assess the relative 'organicity' of core-reduction processes (cf. Boëda 1997: 30f., 2013: 89-97). Analogous to the techno-functional analysis of tool-systems, the strategy is to identify 'significant' core-parts and to investigate their changing functional role. In general, the 'significant' parts of core-reduction systems not only consist of the physical components of exploited core-volumes, but may also comprise non-lithic aspects such as knapping techniques and utilised knapping supports (i.e., striking tools). For the present purpose, however, it is sufficient to concentrate on aspects of the exploited core-volume itself.

Boëda (1997: 30f., 2013: 89-97) distinguishes between 'additive' structures (*structures additionelles*) and 'integrated' structures (*structures integrées*) of lithic reduction. The basic question is whether an exploited volume is used globally, in which case the entire volume is rendered functional, or whether the volume is only used partially, in which case at least one portion of the core-matrix has limited functionality in the reduction process.[763] The concept of the *« volume utile »* ('utilised volume') reflects this logic of reasoning: the 'utilised volume' may be identical with the core-matrix or it may qualify only a proportion of it.[764]

The concept of the *« volume utile »* may be understood rather narrowly or more inclusively. In the first case, the 'utilised volume' is defined by the configuration of the reduction surface and its capacity to yield particular blanks. In the second case, the 'utilised volume' not only specifies the potential volume of primary production, but also includes those parts of the core-matrix that facilitate this production – these parts may be constructed and maintained or not.[765] Core features such as striking platform(s), core flank(s), and/or core back(s) may then be identified as potentially functional or 'effective' elements of reduction systems.

The logic is similar as in UTF-analysis: some of these elements and parts may play an 'active' role during volumetric reduction, others a more 'passive' or 'regulatory' one. When all of these parts

---

[761] This indirect arrangement of tool-systems in time presupposes the 'synthetic' understanding of a 'functional schematic' (or 'technical essence') which is carried through by the respective technical lineage. Tool-structures which are not included must be shown to realise another 'functional schematic.'

[762] The approach is 'integrative' because the specification of relevant lithic objects is part of the interpretive task. Disentangling synchronic technological contexts to extract meaningful diachronic trajectories emerges as a central undertaking in techno-genetic inquiry. Sampling, therefore, is typically highly selective and rarely takes all lithic objects in an assemblage-context into account. *What needs to be studied in its entirety is not the lithic assemblage itself but the technical lineage*. As a consequence, everything that doesn't belong to the targeted lineage(s) needs to be (at least temporally) explained away. Even sampling strategies, for this reason, cannot be separated from world theory commitments, and it is not surprise that UTF-driven analysis is often based on sample sizes that 'mechanism' and especially 'formism' would regard as insufficient.

[763] This concept can also be applied to tool-system. Tools may then be analysed in order to determine whether the entire tool-volume is 'functional' or whether some parts remain 'non-functional' in some specified sense. The conception of the 'pluri-tool' (see *supra*), for example, often implies an 'additive' tool-structure (cf. Chevrier 2012: 158) – tool-edges are simply *added* to an artefact-matrix and can theoretically be removed at any time without unmaking the entiry tool-system.

[764] Boëda's (2013: 41) notion of *hypertélie* ('hyperdevelopment'/'overdevelopment') can be interpreted as the tendency of 'organic' technical evolution to remove unnecessary or redundant elements; reducing *hypertélie* (*sensu* Simondon 1958: 50f.) thus opens another pathway towards 'concretisation.' According to Boëda, the trend to abolish *hypertélie* in technical evolution leads to the well-known phenomenon of *miniaturisation*, both in lithic core and blank domains. This lithic 'miniaturisation' is nothing else than the gradual elimination of 'non-used' parts of the volume ('non-utilised volume') and a more tight spatial/volumetric integration of the remaining parts, which ultimately results in increased levels of lithic specialisation.

[765] The inspiration for distinguishing between 'additive' and 'integrated' reduction structures probably derives from the classic Boëdian dichotomy between 'facial'/'surface-exploiting' and 'volumetric'/'volume-exploiting' technologies – ideal-typically identified with Levallois reduction and volumetric blade production of Upper Palaeolithic type respectively (cf. Boëda 1990). Classic Levallois reduction systems offer a welcome example to illustrate what is at stake when one applies the distinction between 'utilised' and 'non-utilised'/'residual' volume-parts in lithic technological analysis. In the case of the classic tortoise-like Levallois core, the constructed hierarchy between the two distinct hemispheres (often asymmetric) creates one part which is 'active' – that is, serves as the volume-matrix to retrieve Levallois blanks during primary production – whereas the other opposing part remains 'passive' – its role is limited to indirect convexity-regulation. However, by serving as the basis for re-preparing the perimeter and controlling the striking platform etc., the surface also has an in undeniable role to play in the reduction system as a whole. Even though this role is not 'active' in the sense that the volume is used for blank extraction or something similar, it has a well-defined system-level function – *it helps to bring forth the desired blanks*. This clarification is important if we wish to apply Boëda's (2013: 89-97) interpretive categories: if one defines the idea of the 'utilised volume' too narrowly, the Levallois core appears to be only partially used; if one defines the concept more inclusively, however, the Levallois core comes into view as a globally used volume-body.

are integrated – that is, only in concert ensure the overall efficacity (*efficacité*) of the reduction process – and the entire volume can be utilised, one faces a relatively 'integrated' reduction structure. Otherwise, one has identified a lithic reduction structure situated more towards the 'additive' end of the spectrum of possible structures. Again, each element is considered a 'fragment' of a larger technical reality and it is through the analysis of each fragment's potentiality of integration (defined by its 'nexus') that the relative 'organicity' of core-reduction structures can be determined. 'Additive' structures tend to be 'abstract' because the synergetic potential of the parts has not been realised yet. Conversely, 'integrated' structures tend to be 'concrete' for the opposite reasons.

A complete integration of core reduction processes, however, also requires temporal coherence. Boëda (2013: 90-92) introduces the distinction between 'homotetic' and 'non-homotetic' core reduction to address this issue. 'Homotetic' core reduction (*caractère homotétique*) is when the reduction structure, once installed, can be kept constant during the entirety of the reduction process. 'Non-homotetic' core reduction (*caractère non homotétique*), by contrast, is when the reduction structure has to be re-created or altered at least once during the reduction process. Consequently, lithic reduction can only develop high levels of inclusivity when a 'homotetic' character is assumed since it is only then that the temporal organisation of reduction is 'harmonised' or 'synchronised' with its spatial organisation.[766]

Boëda's (2013: 100-174, esp. Fig. 97) six-tiered evolutionary scheme, identifying a general developmental progression from 'Type A' to 'Type F' reduction structures, attempts to order core exploitation systems according to these criteria. The scheme epitomises classic organicistic reasoning and presents a single technical trajectory thought to incrementally strive towards the 'organic' ideal of core reduction (see esp. *ibid.*: 147, 151-174).[767] 'Organicity' is thereby simply the measure for the *relative technical coherence* between the structural key features of different core exploitation systems outlined above.

All of this clearly demonstrates that the techno-genetic paradigm is powered by the structural categories of organicism and its particular logic of 'world making.' This infusion of techno-genetic thought with life-oriented metaphors and concepts is not least reflected in a prevailing pre-occupation of the lithic discourse with *« mémoire oubliée »* ('lost memory') (e.g., Lepot 1992/1993: 28; Bonilauri 2010) and *« altérité technique »* ('technical otherness') (e.g. Chevrier 2012: 11, 87; Weyer 2016: 23)[768], terms which prominently feature in many techno-genetic accounts and play an key role in Boëda's *Techno-logique & Technologie* (2013). The two conceptions can be interpreted as a refinement of basic organicistic categories – i.e., heterogeneity, subjectivity, object-specificity, and alterity – revealing some of the larger implications of approaching lithic technology form an organicistic perspective. Both concepts are best understood in tandem (*ibid.*: 42) – as a product of the specific, yet often tacit, anthropological agenda of techno-genetic investigations.

The techno-genetic approach arguably conveys a radical anthropological impetus. Its techno-deterministic orientation paves the ground for a *radical anthropology of technology*. Although this assertion initially sounds paradoxical, it turns out to be the logical consequence of how humans and lithic technologies are conceptualised. The core idea of techno-genetic reasoning is that technology, in

[766] The cardinal example of 'homotetic' reduction with elevated levels of 'organicity' is Upper Magdalenian blade production of the Paris Basin. The often large blade-cores are carefully and extensively prepared, so that their initial appearance mimics a bifacially worked piece with biconvex outline. These 'pre-cores' are then exploited bidirectionally, by using a rather redundant flaking algorithm, alternating serial blade-removals from both striking platforms. The result is the potential to quickly exploit almost the entire volume of the cores. The main reason for discarding cores is not their 'non-functionality,' but rather their incapacity to produce blanks of particular sizes – the residual cores are simply too small to fulfil certain blank-requirements. The fact that the cores are not fully exploited is therefore not the result of structural constraints but instead reflects particular human selection preferences. The main point, however, is that the core structure, including exploitation strategies, can be kept fairly constant during the entire reduction process, once it has been installed by extensive preparation. Moreover, almost all structural features of the reduction process support each other in their functionality. For example, tangential soft hammer percussion yields *en éperon* prepared blanks smoothly extending down the exploitation surface while keeping the central surface convexities rather intact. Additionally, alternating series of blade-removals from two directions introduce an element of 'auto-preparation:' they balance the amount of material removed from both sites and thereby *auto-regulate* the structure of the primary extraction-convexities. The dynamics of the system hence establish self-organisational principles – principles which are also considered characteristic for living and quasi-living systems. Because many technical elements work together in these and similar ways, the total reduction system can be said to be relatively 'organic.'

[767] According to Boëda (2013: esp. Fig. 97), 'Type A' to 'D' represent relatively 'abstract' reduction structures, while 'Type E' and 'F' exhibit relatively 'concrete' reduction structures.

[768] See esp. the research project *L'altérité technico-culturelle du continent asiatique durant la préhistoire: peuplement et changement culturel* (2010-2013) sponsored by the *French National Research Agency* (ANR) and directed by Hubert Forestier and Éric Boëda.

contrast to proper living systems, constitutes a *semi-autonomous* life-form (cf. Chevrier 2012: 100). The reason is of course that although technology is capable of self-determining its direction of development,[769] it always needs to be created, reproduced, and/or maintained – it thus generally depends on hominins and their societies to survive. Hominins, however, are also not in full control. Following the 'Early' Leroi-Gourhan and others, it has to be admitted that these hominins, before anything else, live in an 'internal milieu,' part of which is the 'technical milieu,' and only secondarily, through mediation, come into contact with their external (natural/non-technical) milieus (Boëda 2013: 223). As a consequence, they can only survive by being receptive to the requirements of their technical surroundings and by consulting the latter's possibilities.

The resultant conflict between hominins and their technologies creates both leeway and constraints for technical evolution – both agencies, although very different in nature, have to be coordinated. Arguably, this is precisely the scenario that is implied when proponents of the techno-genetic approach insist on *human-technology co-evolution* (cf. Boëda 2005: 47, 2013: 22-23, 42). This emphasis on the 'co' entails a methodological *symmetrisation* of human and technological domains, recasting *Homo faber* as *Homo coordinans* (*sensu* Schick 2018).[770]

The specificity of human life, in this view, consists of the fact that it is irreducibly bound to self-created technical worlds.[771] Humans, as a consequence, cannot escape but have to *deal* with this world and to *coordinate* their actions with it – different technical worlds thereby imply different possibilities of coordination.[772] Thus, the human comes into view as a being fundamentally defined by its *technological condition* – a situation that Bernard Stiegler (1994 [2009]: 201f., 2003) has characterised as the distinctive 'pharmacological condition' of humanity.[773]

The organicistic logic of this account is pervasive. First, a distinction is drawn between two 'modes of existence' – one anthropological, the other technological – only to reveal that there is developmental 'conflict' between them. Secondly, it is shown that the conflict can be resolved by finding a new synthesis between the two. In order to make the synthesis happen, thirdly, the two conflicting parties have to converge their developmental potentials in order to establish a new stable state of relative *symbiosis*. This new stable state, realising one or more meeting points of the appendant 'nexuses,' inevitably forces both parties to change. The conclusion is that change must be understood as an organic co-evolutionary process.

If organic co-evolutionary processes are realised by long-term technical trajectories, these trajectories convey human-technology configuration which are specific to them. They can be interpreted as a distant voice of past humans *and* past technologies. Techno-genetic approaches therefore typically define themselves in direct opposition to any kind of sociocultural reductionism.[774] The critique is primarily voiced against lithic 'contextualism' which tends to re-cast each historically situated context as a

---

[769] Audouze (2013: 18), for example, explicitly speaks about technological 'vitality' to describe the quasi-autonomy of lithic technology.

[770] As indicated by the preceding sentence, this 'symmetrisation' can only be methodological since humans and technologies exhibit different 'mode of existence.' They legislate over their respective other in very different ways and potentially at different temporal scales. The involved 'power-relations' are thus asymmetrical, but it remains difficult to say who is actually 'in the driver's seat.'

[771] The subtle but important difference between 'contextualistic' and 'organicistic' readings of the evolutionary significance of human-created worlds is notable here. The former typically emphasise the inextricable *enmeshment* of humans and their worlds, crystallising in the conception of the Maussian *l'homme total* (see also **Appendix II.3**), whereas the latter tend to underscore the ontological *difference* between humans and their artificial material worlds. From an 'organicistic' perspective, human-created technical worlds may accordingly acquire a status as *semi-independent forces* in human evolution.

[772] Because this technical world evolves, whether humans want it or not, it provides a *resonating resistance* to human action, creating existential 'conflict' and thus also the potential for solving it. Each such solution therefore implies coordination and development, sometimes even creativity and innovation (see *supra*).

[773] According to Stiegler (1994, 2004a), living in a technical world is a double-edged affair: on the one hand, technology is an enabling force and allows us to do certain things; this is what we normally refer to as the inherent instrumentality and potentiality of technology. On the other hand, however, technology also constrains and/or channels human action and narrows down the available options; this is the inevitable techno-deterministic dimension of human technical existence. Stiegler captures this duality with his notion *pharmakon*. Technics, in his view, are always both 'cure' and 'poison' at the same time, both humanity's potential salvation and its doom and ruin (Stiegler 2010). The technological nature of human existence thus simultaneously frees and condemns. For Stiegler (2009 [1994]: 201-202, 2006: 115), this 'pharmacological condition' is the *sine qua non* of what it means to be human.

[774] In France, there are currently some efforts underway to re-establish 'anthropology' as a separate discipline with its own subject-matter (e.g., Piette 2010, 2011). These efforts are bound to the recognition that the 'anthropological' cannot properly come into view if it is reduced to the 'social' or 'cultural.' In general, this endeavour seeks to define a new (and somewhat radical) anthropology, in which anthropological and not merely sociological or 'culturological' questions can be investigated – the goal is to free anthropology from 'the tyranny of sociology and ethnology' (Piette 2017). This approach also stresses the critical *object-specificity* of anthropological research (Piette 2016).

singularity. Having said this, the critique may also apply to some branches of *« Paléohistoire » sensu stricto* where social evolution is volitionally foregrounded (e.g., Bon 2009, 2015). Taken together, we may conclude that the techno-genetic endeavour seeks to establish a proper *techno-logical anthropology of the deep past* – an anthropology where *technology* has a crucial say.

The notions of *« mémoire oubliée »* ('lost memory') and *« altérité technique »* ('technical otherness') bespeak of this anthropological significance of technical lineages. The first concept – *« mémoire oubliée »* – focalises the non-material dimension of co-forged trajectories – the fact that they are the product of specific forms of mind-matter interaction, *as such* storing a particular sociotechnical memory.[775] Since most technical lineages went extinct long ago and have no connection to the present, the memory that they record is 'lost' and cannot be retrieved from the technical inscriptions of the modern world anymore (Boëda 2013: 226-230).[776] The second concept – *« altérité technique »* – is both a consequence and a precondition of the first (*ibid.*: *42*); it reflects the conviction that the specific coordinative accomplishments [*Koordinationsleistungen*] that have incrementally given shape to a technical lineage are to be interpreted as a convergence of mind and matter never achieved in this particular manner again in human evolution. The particular technicality that 'fossil' lineages convey therefore expresses an irreducible anthropological 'otherness' – it provides evidence for *alternative humanities* to have existed in the deep past.

The study of long-term technical trajectories in the Palaeolithic is hence also the study of how we *could have been*. It opens the gates for a fundamental inquiry into *human life* itself, with the intent to re-map its inherent developmental potentiality.[777] In general, it is therefore not surprising that techno-genetic research has paid much attention to disconnected geographic areas (e.g., Boëda and Hou 2004; Li et al. 2009; Forestier 2010; Forestier et al. 2010; Boëda and Hou 2011; Boëda et al. 2013a, 2013b, 2014, 2015; Nicoud et al. 2016; Wei et al. 2017; Chevrier et al. 2017). The aim is to identify and characterise local evolutionary trajectories and to compare them on a global scale (e.g., Chevrier 2012; Moncel et al. 2016a, 2016b, 2016c; Weyer 2016). The focus lies on 'technical alterity' in its chronological and geographic dimensions. This focus, *grosso modo*, issues the antithesis to research agendas seeking to uncover *behavioural modernity* in space and time – agendas that are predominantly pursued by Anglophone scholarship. Techno-genetic analysis is interested in technical 'otherness' and its implications, not in the question of 'modernity.'

To conclude, the techno-genetic paradigm is built on concepts and ideas which are predominantly organicistic. These concepts not only feed into general theories of evolution, but have left a deep mark on the concrete methodologies devised to understand the 'structure' of lithic technology themselves. This notion of 'structure' differs from the signification of the same term in 'contextualism': it serves a much greater purpose – namely, to reconstruct technical lineages – and is primarily analysed

---

[775] Boëda (2013: 223f.) draws on Stiegler's (1998, 2004a, 2009 [1994]: 234-236) notion of *« épiphylogénèse »* ('epi-phylogenesis') to clarify the nature of 'lost' sociotechnical memory. This memory is primarily 'material,' but is cultivated and created by processes of 'epi-phylo-genesis.' The latter describes, as Stiegler points out himself, a fusion of Leroi-Gourhan's (1964/1965) concept of 'exteriorisation' and Bergson's (1896: xi) idea that 'memory' forms the natural point of intersection between mind and matter (cf. Copleston 1994 [1974]: 190). The core idea is rather simple: the long-term co-evolution of humans and technologies nurtures specific bodies of practical and theoretical knowledge in need of being stored outside of biological organisims, that is, 'epigenetically.' Technology itself is a suitable extra-somatic carrier information because of its longevity and its consequential ability to bridge past, present, and future. For Bergson (1896: 294), memory is formed in duration and generally yields "a synthesis of the past and the present in view of the future." Such a synthesis can only be provided by 'technical lineages,' which thereby come into view as products of 'epi-phylo-genetic' evolution. The *« mémoire épiphylogénètique »* ('epi-phylo-genetic memory') embodies by varying such lineages is different from Halbwachs' (1925, 1950) *« mémoire sociale »* ('social memory'). It primarily concerns inscriptions of practical, cognitive, and technical significance. These are thought to precede the social and symbolic inscriptions of the *« mémoire sociale »*. The externalised memory of technical lineages sheds light on the becoming of general constellations of *« manières de faire »* ('ways of doing'), *« manières de voir »* ('ways of seeing'), and *« manières de vivre »* ('ways of living') (*sensu* Stiegler 2009 [1994]: 145; cf. Boëda 2013: 226-230).

[776] Because the modern world is a product of its own lineage-ecology, extinct – that is, 'fossil' – lineages and the knowledge they convey cannot be illuminated by drawing on the present. This trail of reasoning implies another forceful critique on universalistic accounts basing their explanatory principles on observations in the present. In the context of lithic research, a prime target of this critique is 'Middle Range' theorising, practiced both by lithic 'formists' and 'mechanists,' as well as 'uniformitarian' reasoning, mainly advocated by 'mechanists.'

[777] The fact that different 'technical lineages' are thought to realise differential facets of the human evolutionary potential shows that 'plasticity' and 'elasticity' are granted only on hyper-evolutionary timescales. Plasticity, for example, consists not in the ability to adapt to particular environmental circumstances as optimal as possible, but rather in the capacity to accumulate a myriad of different sociotechnical outfits to live in a generally difficult world in a myriad of different ways. Human plasticity, in this view, can only properly be studied if divergent long-term trajectories of human-technology co-evolution are compared. Put differently, within a given technical lineage plasticity is often critically reduced, yet the juxtaposition of different technical lineages reveals that human technicity, on a general level, turns out to be highly plastic indeed.

to determine the relative 'organicity' and self-regulatory capacity of different technical entities. Techno-genetic research has thereby adopted a view of technical evolution that foregrounds internal 'organic' development and integration – a view inspired by life-theoretical currents of technological and cybernetic thought in France. Some of the respective ideas have led to a basic reconsideration of the nature of lithic technology and its role in early human evolution.

An important result of this reconsideration has been the re-cultivation of the classic concept of the *Homo faber* ('technical man'), placing renewed emphasis on the primacy of human technicity and the difficult becoming of coupled 'anthropo-technical systems.'[778] This accentuation of the *Homo faber* is tied to a vision of human evolution inspired more by Bergson than Darwin.[779] After all, it was Bergson who initially coined the concept of the *Homo faber* and it is – perhaps unsurprisingly then – Bergson who is cited at the very beginning of Boëda's latest book (2013):

> "[…] If we could stray ourselves from all pride, if to define our species we would strictly adhere to what history and prehistory present to us as the constant characteristic of man and intelligence, we would perhaps not say *Homo sapiens*, but *Homo faber* instead." (Bergson 1959 [1907]: 613; cited by Boëda [2013: introductory citation] and original emphasis; my translation [the original French quote is given in **Appendix Q.22**])

[778] See Hussain (2018) for a more detailed discussion on the role of the *Homo faber* in French lithic research, including the significance of 'technicity' as a concept.
[779] For Bergson's critique on Darwinian evolution, see e.g. Miquel (2007).

Chapter 6

Conclusion: conceptual equivocality, pluralism, and critical practice at the French-Anglophone boundary

"You can disagree without being disagreeable"

– Ruth Bader Ginsburg

"[...] *The point is that we now have, and are likely to continue to have, no fully adequate world theory, but a number of alternative rather highly adequate world theories, each of which is able to describe or interpret any presented fact, criticized or uncriticized, but each of which contains some internal ulcer of self-contradiction.*"

– Stephen C. Pepper (1935: 370)

Abstract

This chapter reviews the key insights of the foregoing examination and discusses their significance for understanding and navigating lithic research conflicts at the French-Anglophone boundary. I show that the conceptual toolkit supplied by Pepper not only helps to clarify the stances typically taken by French and Anglophone practitioners, but also throws new light on old problems and helps to pinpoint issues that have hitherto been overlooked or neglected. The result is a new epistemological assessment of the French-Anglophone divide, re-casting it as a clash of two pairs of world theories. It is argued that the diversity of incompatible yet equally tenable approaches characterising the divide should encourage scholars to devise a 'pluralistic stance.' Some of the more pertinent consequences for criticising and interacting with cognitive 'others' are spelled out. Following Pepper, I defend the view that lithic knowledge can only satisfactorily be advanced if we find meaningful ways of communicating with the 'other' and to pool the evidence gathered by all of the four perspectives on the lithic record. This 'engaged pluralism' compels lithic researchers to re-consider 'critical practice' in their field. Ultimately, cognitive contenders must come into view as highly competent experts rather than misguided caricatures. More epistemological work is required to facilitate cross-theory interaction and to work out the relative strengths and weaknesses of the four major axes of lithic inquiry in different research contexts. The chapter concludes with a brief discussion of future research potentials at the French-Anglophone interface.

6.1 A review of main findings and arguments

The comparison of the various lithic approaches adopted by French and Anglophone researchers (Chapters 3 to 5) has shown that the two groups draw on fundamentally different cognitive resources. Based on Stephen Pepper's world hypotheses theory, it has been established that much of this results from a differential reliance on *world theories* – that is, theories of a global scope concerned with the fundamental constitution of the world (Chapter 2). The fact that divergent strands of French and Anglophone lithic research are based upon unequal 'world hypotheses' has important ramifications for the quality and nature of the French-Anglophone divide. On the one hand, it shows that conflicting knowledge claims emerging at the French-Anglophone interface (Chapter 1) are likely rooted in the 'underdetermination' of the available evidence through world theories. On the other hand, the successful application of Pepper's conceptual categories to the French-Anglophone divide clearly suggests that the division is about more than a local clash of methods or imperatives of inquiry. Instead, we have to come to grips with the circumstance that the divide signifies a *global* bifurcation of knowledge production in lithic research. The three instances of interpretive conflict outlined in Chapter 1 must therefore be understood as the consequence of the deployment of substantially different conceptions of worldly order and the fabric of reality.

On a general level, the present study clearly suggests that French and Anglophone lithic experts are typically divided by their vision of the primary goals and interests of scientific research: while the former tend to conceive of lithic inquiry as a 'synthetic' endeavour, the latter define it mainly in 'analytic' terms. The 'analytic' conviction considers parts as basic and wholes as the derived features of the world; the 'synthetic' counterpart, conversely, regards wholes as basic and parts as the derived features of the world. Chapter 3 has shown that this basic opposition is already reflected in how lithic assemblages are prepared, studied, and recorded. Pepper's 'analytic'-'synthetic' dualism dictates the nature of the lithic research enterprise on both sides of the French-Anglophone divide and affects research designs, patterns of inference and argumentation, strategies of visualisation, and the character of the interpretive concepts brought to bear. The nature of lithic data and their relationship with the realm of theory similarly depend on whether one adopts an 'analytic' or a 'synthetic' mode of reasoning.

While the French-Anglophone divide in lithic analysis can be rather consistently described as an expression of the basic difficulty to cross the 'analytic'-'synthetic' boundary, the internal diversity of French and Anglophone approaches cannot sufficiently be accounted for by invoking its categories. We have seen that this internal diversity can be reconstructed as a give and take between 'dispersive' and 'integrative' world theories – in the French case by a 'synthetic' pair, in the Anglophone case by an 'analytic' pair. As a result, French lithic research tends to be either 'contextualistic' or gravitates towards an 'organicistic' perception of past realities; Anglophone lithic approaches, contrarily, tend to be either 'formistic' or to rely on a 'mechanistic' conception of worldly affairs. Although this general framework may not explain all the facets of internal variability, the successful application of the theories' structural categories to the selected case studies (Chapters 4 and 5) suggests that it is at least able to capture the main strands of investigation in the two research spheres. The fact that the selection of case studies was based on a careful historical survey of French and Anglophone lithic traditions supports this conclusion (cf. **Appendix III.4**).

It can therefore be generally concluded that Pepper's four-tiered landscape of Western thought allows us to capture both how French and Anglophone lithic approaches are *externally related* and how they are *internally structured*. The first aspect clarifies the nature and the stakes of the French-Anglophone divide; the second aspect helps to explain why much internal friction persists on either side. Much of the originality of the two approach families, accordingly, stems from the fact that their 'dispersive' and 'integrative' categories interact in particular ways (or not). The dynamic interplay of these categories produces much of the 'discursive space' proper to both French and Anglophone lithic research. This interplay further elucidates the types of eclecticism regularly encountered in both domains of lithic research.

Judging from what has been found in Chapters 4 and 5, it seems that the more 'integrative' strands of each research sphere – 'organicism' and 'mechanism' respectively – often draw on the systems of classification and typologisation established by their 'dispersive' sparring partners – 'contextualism' and 'formism.' The reason is that the latter are naturally more concerned with *organising* the totality of the available lithic evidence, to deal with the 'broadside' of evidence, and to broaden their classificatory schemes. Expanding and proliferating the lithic evidence as well as grouping it is hence much more important for these world theories. This tendency, of course, is particularly pronounced in 'formism' which strongly relies on what Pepper names the 'Theory of Types.' Yet, the 'integrative' strands do not draw on these 'dispersive' categories uncritically. A typical strategy is to analyse the respective categories and to establish their 'effectiveness' or 'ineffectiveness' in providing focussed explanations. This intricate relationship between 'integrative' and 'dispersive' research orientations is expressed by the 'mechanistic' tendency to muster 'formistic' types and/or typologies and to analyse their causal/functional significance or their formation history. Similarly, it is reflected in the 'organicistic' inclination to draw on the 'contextualistic' foundations of *chaîne opératoire* analysis and to rearrange the derived categories in order to assess problems of evolutionary becoming. These kinds of borrowing may lead to a mixture of world theory orientations, even motivating proper eclecticisms. An example is *« Paléohistoire » sensu stricto* which tends to examine its lithic evidence primarily in 'contextualistic' fashion, but seeks to interpret the findings according to a logic proper to 'organicism.'[780]

At the same time, the findings of Chapters 4 and 5 appear to suggest that the more 'dispersive' lithic approaches often import basic 'integrative' conclusions to render the relationships, distributions, and patterns they detect significant. General 'integrative' explanations such as the 'mechanistic' insistence on the fact that different lithic types may represent the physical manifestation of different temporal locations on a continuous spectrum of reduction are invoked to enrich 'dispersive' accounts and/or to illuminate some of their documented data structures. For this reason, 'integrative' insights easily become role models of explanation for 'dispersive' research; they are more readily regarded as 'simple' or even 'best' explanations, helping 'dispersive' approaches to overcome their difficulties with a relatively unconstrained space of interpretation (cf. **Appendix II.2**). A good example is 'formism,' which often turns the most potent causal factors identified by 'mechanism' into its 'subsistent' categories. This strategy regularly results in a broad discussion of the many potential 'subsistent' categories furnished by 'integrative' research, comparing them to the available lithic data in terms of (dis-)similarity.

Generally speaking, we rarely encounter any of the four relatively adequate world theories in their 'pure' state. This may not be surprising, however, since lithic practitioners are often pragmatic about their research[781] – research which is not only constrained by cognitive factors.[782] Moreover, lithic research – as most other types of scientific investigation – is a rather *difficult* undertaking, and its socio-political context often complicates matters. Another important factor to consider is history. Although Palaeolithic archaeology, compared to other fields, has a rather short disciplinary history, its research similarly depends on the cumulative efforts of preceding generations of scholars.

In addition, once established concepts, terms, and/or interpretations are often difficult to eliminate and may entrench themselves in the discursive space even if they embody a logic of inquiry which is no longer compatible with the latest instalments of research. An example is the role of 'Bordian' types in the French scene: they are a vestige of a 'formistic' intermezzo in lithic research – the 'Bordian era' (*sensu* Sackett 1991) – but have now become indispensable since they greatly facilitate scholarly communication and enable the quick description of morphological tool-variability.[783] For these and similar reasons, it is more than likely that disciplinary history remains a potent source of eclectic tendencies in both lithic research spheres.

Given these trends for eclectic excesses, the demonstrated capacity of Pepper's metatheoretical framework to explain many, if not all, of the major axes of divergence between French and Anglophone lithic practice and to shed new light on the internal organisation of the two should convince even the last sceptic that the four relatively adequate world theories are *significant* for understanding the French-Anglophone divide. Although it has to be admitted, as indicated before, that this new perspec-

---

[780] On a relative scale, one may say that *« Paléohistoire » sensu stricto* seems to be characterised by a delicate balance between 'contextualism' and 'organicism' whereas the 'techno-genetic approach' leans much stronger towards 'organicism.' This is for instance reflected in Boëda's (2013) six-tiered scheme of lithic technological evolution ('Types A to F'), representing a reorganisation of basic 'contextualistic' technical entities based on explicit 'organicistic' considerations (see Chapter 5).

[781] Taking into account Anglophone lithic research, one cannot help but get the impression that in the more recent past 'formism' has become the preferred mode of investigation when lithic reports are authored; 'mechanism,' by contrast, is the preferred (or at least most successful) mode of investigation when peer-review papers are designed and written. This trend of course also reflects the particular format of these two types of publication: 'formism' for instance, due to its 'dispersive' nature, easily supports large numbers of tables and figures including extended appendices; 'mechanism' by contrast provides a 'focused' treatment of the lithic evidence and is thus much more compatible with high-profile peer-review journals of limited scope. To give an example, Dibble and McPherron (2018: xv) explicitly invoke the notion of lithic 'metadata' to justify the 'report mode' of handling lithic information – they also contrapose this mode of presenting data with lithic data treatment in specialised journals. The general pattern, if robust, may indicate another way of conceptualising the cognitive division of labour at the interface between 'formism' and 'mechanism.'

[782] Publication-pressure, for example, is an important institutional factor leading to increased output rates. This increased output typically also increases the likelihood and motivation to embrace eclectic tendencies – eclecticism offers a relatively easy road to recombining and reinterpreting already available evidence.

[783] The fact that 'Bordian' types are, strictly speaking, no longer fully compatible with French technological analysis is also reflected in the fact that they are slowly but surely abandoned by the emerging 'organicistic' strands of research (see Chapter 5).

tive may play down some nuances of the prevailing research variability, the gains clearly outweigh this minor disadvantage. The structure of the four world theories not only clarifies why French and Anglophone lithic approaches tend to disagree on all levels of inquiry, it also provides insight into the internal dynamics that shape them; this, in turn, helps to understand the dominant eclectic tendencies in both spheres of inquiry. The world theory perspective balances understanding and complexity – it offers a relatively simple explanatory scheme while providing high degrees of insight.

By invoking some basic concepts from the philosophy of science, one can acknowledge that French and Anglophone lithic practitioners adhere to hardly overlapping research 'paradigms' (Kuhn 1996 [1972]), typically pursue diverging 'research programmes' (Lakatos 1970, 1977) and take part in distinct 'communities of thought' (Fleck 1936, 1979 [1935]) promoting dissimilar 'styles of reasoning' (e.g., Fleck 1979 [1935]; Hacking 1985). The precise relationship between these tokens of lithic research, in turn, appears to be regulated by the cognitive resources supplied through varying world theories (Pepper 1935a, 1942).

In many regards, the argument converges with Perlès' (2016) recent review of French-Anglophone relations in lithic scholarship. She concluded that French *technologie lithique* and Anglophone lithic analysis, geographically divided by two major water bodies (the Atlantic Ocean and the English Channel), are currently experiencing the consequences of a "full divorce" of approaches already initiated in the second half of the last century. The results of the present study are in general accordance with this assessment. Yet, it cannot be overemphasised that especially in the French scene the full potential of the 'divorce' has only taken shape in recent years, with the development of well-defined 'organicistic' research tendencies. From a world theory perspective, it is only consequential that 'synthetic' modes of lithic inquiry gradually differentiate themselves into somewhat antagonistic strands of lithic 'contextualism' and lithic 'organicism.' I would therefore argue that even though the 'divorce' has undoubtedly ancient roots, it has been *completed* only relatively recently.

Before we can turn to the wider implications of the French-Anglophone divide, it seems useful to re-visit a number of old thorny issues, plaguing research in Palaeolithic archaeological for many years. This provides the opportunity to demonstrate that the previously developed perspective can greatly enhance our understanding of these problems and may help lithic practitioners to better navigate them.

6.2 **Towards a new understanding of old problems**

The recognition of the French-Anglophone divide as a manifestation of the basic conflict between 'analytic' and 'synthetic' perspectives in lithic research throws new light on old difficulties. Although I cannot provide a comprehensive coverage of research issues emerging at the French-Anglophone interface, a few examples can be given to illustrate the benefits of employing Pepper's world hypotheses theory. World theory differences can for instance be invoked to apprehend (i) the long-established dissonance between *chaîne opératoire* analysis and the lithic 'reduction sequence' approach, (ii) tacitly acknowledged discrepancies in the operationalisation of concepts of 'evolution' and 'adaptation,' and (iii) the often dissimilar employment of dualistic reasoning. The fact that the last point is only rarely recognised in lithic scholarship as a source of interpretive tension clearly demonstrates that world hypotheses theory cannot only *re-construct* known issues, but is also capable to *identify* hitherto unrecognised conceptual problems. This should be taken as an additional indication for the cognitive potency of the theory. The following exposition tries to avoid the introduction of new elements of discussion and should be understood as a problem-oriented confrontation of some of the key findings of Chapters 3 to 5.

6.2.1 ***Chaîne opératoire vs. reduction sequence***

The conflict between French *chaîne opératoire* research and Anglo-American 'reduction sequence' approaches has a long history (Bleed 2001; Perlès 2016). Both *chaîne opératoire* and 'reduction sequence' analyses embody distinct perceptions of lithic technology, amalgamating aspects of lithic method and theory. Even though the two have often been said to focalise similar aspects of research (e.g., Shott 2003, 2007), they differ fundamentally in their epistemological make-up. Drawing on the conceptual structure of the French-Anglophone divide established previously, we can clarify some of the pending issues and develop a new perspective on the two approaches.

The basic difference between the French *chaîne opératoire* and the Anglophone 'reduction sequence' is that they are based on a divergent conception of part-whole relations. In *chaîne opératoire* analysis, originally developed within a 'contextualistic' climate of research (see Chapter 5, first part), lithic artefacts are typically identified as parts of a larger technical context (assemblages, technical systems). This technical context ultimately *legislates over* the parts and hence determines the technological significance of individual lithic artefacts. *Chaîne opératoire* approaches target the 'infrastructure' – the 'texture' – of selected technical contexts and consequently analyse the spatiotemporal relationships between individual artefacts in order to delineate or contrast various technical 'structures' and 'sub-structures' (i.e., groups of artefacts, reduction modalities/methods). Characterising the 'texture' of a technical context thereby helps grasping the 'spread' of its 'quality.' The particular configuration of lithic 'infrastructural' organisation and technical 'quality' defines lithic technology. *Chaîne opératoires* are qualitative entities in this particular sense.

By contrast, the 'reduction sequence' approach typically regards lithic technology as a compositional whole to be derived without loss from its parts. Parts are identified as lithic artefacts which may also be analysed in terms of their compositionality. The consequence is a strong reliance on generic features and well-defined traits or attributes of individual artefacts – lithic technology is ultimately what comes into view as a result of the careful analysis of these lithic 'parts.' Through the optic of 'mechanistic' lithic inquiry, reduction sequences are identified as specific 'fields of locations' in which each effective part – lithic artefacts or their discrete features and traits – occupies an *exact position*. Lithic technology – as a 'reductive' process – establishes a *spatiotemporal field* in which the relations of parts determine the nature of the reduction process (see Chapter 4, second part).

The reconstruction of reduction sequences typically relies on 'objective' time measures, upon which each part can be *localised* in the larger 'field of locations' (dimensionality and cortex proportions are often primary measures of time). Specific constellations of part-features are thought to indicate different technical operations associated with the progression from core selection to core abandonment or tool manufacturing/use. The emphasis, therefore, tends to be on the *chronology* of reduction.[784] Since parts are considered to act on other parts by means of directed causality, different parts may be rendered 'effective' explanatory categories by specifying their position in particular transformational sequences (i.e., lithic types may represent different 'locations' on a continuum of lithic reduction). The classic distinction between 'pattern' and 'process' thereby regularly leads to the identification of lithic patterns as distinct, yet progressive stages within a unified reduction process.[785] The point is that the underlying process is thought to be recognisable by its correlated pattern, allowing scholars to establish relatively stable pattern-process correspondences. The 'Reduction Thesis' (e.g., Dibble 1987; McPherron 1994) is a sensible expression of this general research configuration.

'Formistic' approaches tend to regard lithic 'reduction sequences' as loosely determined 'stone soups.'[786] The structure of lithic technology is described as the relationship between different 'particulars' (lithic artefacts) and/or 'characters' (artefact features, traits) participating in specific patterns. These patterned regularities help practitioners to determine the 'norms' and 'laws' under which matter is transformed into particular forms. Alternatively, different patterns or different configurations of patterns come into view as expressions of relevant 'subsistent' categories (e.g., 'population,' 'social transmission,' 'cognition,' 'tradition,' 'cultural adaptation,' etc.). The basic contention is *hylomorphic* – that is, different technical actions are thought to bring forth matter in varying forms. This is why form-

[784] When 'mechanistic' approaches discuss the relationship between *chaîne opératoire* and 'reduction sequence' they tend to *reduce* the former to a format only compatible with the latter, namely that reduction primarily consists of a directed succession of knapping behaviours starting with the anticipation of a need (raw material selection) and terminating with the satisfaction of a need (core discard, tool use, etc.). This vision foregrounds the chronological coordinate of lithic reduction and tends to marginalise the spatial ('geographic,' 'volumetric') aspects of the latter.

[785] Cf. "[…] It is important to note here that the use of the word "stage" in the context of the reduction strategy does not imply that these stages were somehow recognized by the makers of these artifacts. The word stage is substituted for the word type only to emphasize the connection between them and the idea of a single process. Still, the stages, like the types, are completely arbitrary constructs, and there is absolutely no intention to argue that these stages correspond to actual stages that may have been recognized by the makers of the artifacts (cf. Newcomer 1971). They are simply a heuristic device and no more." (McPherron 1994: 39)

[786] The term 'stone soup' is not my invention but can for example be found in Tostevin (2012).

based classification and typologisation are so central for approaching lithic reduction sequences in 'formism.' Relevant forms are either identified with specific patterns or with distinct artefact types/classes. The determination of *signature patterns* characterising specific reduction sequences remains typical for this approach.[787] As in 'mechanistic' research, lithic analysis is largely a part-centric endeavour. In total, 'formistic' perspectives on reduction sequences seem to foster *descriptive conceptions* of lithic technology.

This reconstruction not only shows that the term 'reduction sequence' conceals much internal variability, but also substantiates the claim that *chaîne opératoire* research is grounded in a 'synthetic' interpretation of lithic technology, while reduction sequence approaches derive and handle lithic data 'analytically.' Another important benefit of recasting the lasting schism between the two approaches in 'Pepperian' terms is that we can now understand why the two struggle so much with finding a basic consensus about the *nature* of lithic reduction. The various examples presented in Chapter 1 make it amply clear that a key source of conflict is the debate on 'discrete' vs. 'continuous' reduction. We have seen that Anglophone scholars strongly gravitate towards a 'continuous' conception of knapping behaviours, whereas French lithic experts actively embrace 'stage-based' perceptions of the same. Indeed, key aspects of the documented interpretive polarities appear to be a product of the thorny dichotomy between 'discrete' and 'continuous' processes of lithic reduction.

Based on what has been concluded before, it can be argued that this dichotomy seems to be a consequence of the intrinsic constitution of the various world theories at work. 'Contextualistic' and 'organicistic' approaches to lithic technology both exhibit a strong disposition for advancing a 'discrete' vision of technological organisation, but for different reasons. The optic provided by lithic 'contextualism' enables the exposition of situated artefact relations and their arrangement into sub-units of technical wholes; this sorting of inter-artefact relations by means of delineating technical structures and their sub-structures greatly motivates a 'discrete' reading of *chaînes opératoires*. Technical wholes come into view as a 'fusion' of various technical 'sub-contexts' succeeding each other in time. These 'sub-contexts' are endowed with 'novelty' and necessarily bring 'change' – the temporal axis of the 'infrastructure' of technology appears to be *textured*.

In the eyes of 'organicism,' the 'discrete' character of lithic technology is even more aggravated. The 'organicistic' categories uniquely stress the *discontinuous continuity* of temporally extended reduction structures (see Chapter 5, second part). Lithic reduction, as a 'concealed' organic process, is conceptualised as a step-wise movement of parts towards the fulfilment of their structural 'ideal' – the temporal 'integration' of lithic reduction structures is mediated by distinct 'stages.'

'Formism' and 'mechansim,' in comparison, tend to motivate 'continuum' approaches to lithic reduction. This is already foreshadowed by the fact that both enterprises are mainly guided by the question of how lithic parts *produce* their whole(s) rather than how these parts *serve* their whole(s). 'Mechanistic' approaches, moreover, conceptualise reduction sequences as 'fields of locations' implying that each part – typically a lithic artefact – holds a single spatiotemporal position which, in turn, forbids other parts to occupy the same location. Since lithic technology inaugurates its own 'field of locations' and since each lithic artefact fills a particular spot on the field somewhere between the beginning and the end of the reduction 'stream,'[788] the result is a *continuous stringing together* of different lithic artefacts in time. Most lithic 'mechanists' are also nominalists who, incentivised by mustering primarily quantitative data, generally reject what they consider 'essentialised' categories (e.g., Shott 2010; Shea 2014) and believe that there are only tendencies in the world which can be abstracted at best (cf. Chazan 1997: 720; Marwick 2008a).

In 'formism,' the rejection of 'stage-based' views of lithic technology may be even more fundamental. In the extreme, 'formistic' interpretations recognise only 'subsistent' categories or exemplified 'laws,' 'norms,' and/or 'regularities' as 'discrete' features of reality – the realm of 'existence,' by contrast, cannot be 'discrete' in the same sense. Items of 'existence' are always mere realisations of original 'discrete-ness' – the objects of 'existence' generate a *spectrum of forms*, by definition variations of common themes (Chapter 4, first part). This entails a basic inclination to examine lithic reality in its

[787] Tostevin's (2000, 2012) analysis of 'knapping domains' is a good example for a 'formistic' approach to lithic reduction sequences. The author seeks to derive and compare different *signature patterns* from different lithic assemblages. Each 'knapping domain' is defined by a specific constellation of lithic parts. By combining all 'domains' one can reconstruct the 'stone soup' corresponding to an assemblage and confront it with other 'soups.'

[788] The term 'reduction stream' is for example used by Henry (1989b; cf. second part of Chapter 4).

proliferated but continuous constitution.[789] Although artefact-types participating in the same patterns may of course be interpreted as exemplifications of particular reduction phases, but these phases would remain generic and somewhat fixed;[790] they would express the 'subsistent' phasing of all lithic technologies of a similar type.[791] In addition, if the respective patterns are constructed based on a tacit 'theory of sets,' there is by definition substantial overlap and hence much continuity in reduction processes.[792]

For all of these reasons, Anglophone 'analytic' lithic research trends towards 'continuum' conceptions of lithic reduction (e.g., Baumler 1987; Henry 1989b, 1995; Rolland and Dibble 1990; Dibble 1995; Shott 2007, 2017; Scott 2011; Shott et al. 2011; White and Pettitt 2012: 272), whereas French 'synthetic' inquiry typically heralds 'stage' conceptions (e.g., Geneste 1985; Boëda 1986, 1988; Bourguignon et al. 2004). The crucial lesson is that the dichotomy between 'discrete' vs. 'continuous' is difficult to place on neutral grounds – lithic scholars rarely come up with convincing means to evaluate the alternative to their preferred view. Whether practitioners accept the 'continuum' conception or the 'stage' view of lithic reduction seems to depend primarily on the conceptual resources and the types of lithic data they can deploy. Lithic 'contextualists' would in fact challenge the entire discussion because for them the nature of lithic reduction is not a question of natural laws or other universal regularities, but simply depends on the technical context itself – some technologies may be more 'stage-like,' others may support 'continuous' reduction.

This raises the classic issue whether all questions are productive questions. The clash between proponents of 'continuum' approaches and advocates of 'stage' approaches at least seems to show that the answer must be negative. Until an approach is found rendering both contending positions potentially 'true,' the debate remains a 'no-debate.' Arguments to support or dismiss either position, as it seems, currently depend strongly, if not entirely, on the conceptual structure of the adopted world theories.

The general point that emerges from this discussion is that some lithic debates may be pointless. The more fundamental the debate the more likely this seems to be the case. Critical practice in lithic analysis, as I have outlined in Chapter 1, would require to pay more attention to potential 'no-debates' and the pitfalls of overestimating one's own conceptual resources. Coordination between world theories on the discursive level can thus only be successful if both the *potentials* and *limits* of diverging conceptual repertoires are taken into consideration – an aspect we will return to again later in this chapter. For now, it is sufficient to note that some lithic debates, especially the emotionally charged, may simply reproduce irreconcilable differences in how one can understand the nature of reality (and technology) more generally. The challenge, therefore, is not to resolve these issues, but rather to initiate debates that promise to be more productive. 'Pepperian' world hypotheses theory is clearly able to offer guidance in this difficult project.

6.2.2 *Evolution and adaptation re-visited*

'Evolution' and 'adaptation' represent key interpretive concepts for many lithic scholars, especially for Anglophone researchers who tend to rely more explicitly on evolutionary theory. Chapter 4 and 5 have shown that even though similar terms may be applied in French and Anglophone lithic research in this context, the underlying conceptions often greatly differ. Some of these differences echo the structural polarities retraced in the previous section. This has a positive and a negative side: positive is that it

---

[789] See for instance the case of Lycett (2009, 2010) and Archer et al. (2015, 2016) discussed in the first part of Chapter 4.

[790] A recent example showing the difficulties of mass-analytical methods to detect and characterise 'discrete lithic reduction trajectories' is provided by Scerri et al. (2016). Although their study intends to show that 'discrete' knapping modalities can be quantified and detected by multivariate statistical analysis of selected artefact attributes, the results actually support a more sceptical conclusion. First of all, it is shown that not all methods thought to be reliable actually turn out to be equally effective in discriminating between different knapping modalities determined by physical refitting prior to the analysis – different technological modalities may in fact be detectable by different methods; secondly, the paper re-emphasises the basic difficulty to determine the correct combination of attributes in order to effectively discriminate knapping modes *before* one already knows which flake belongs to which mode. In the end, multivariate statistical tests may thus support assertions of 'discrete' technical entities *after* they have been established by other means, but their ability to inductively infer them remains generally limited.

[791] A generic conception of technological phasing is also reflected in the common characterisation of 'reduction sequences' as the succession of predefined steps of lithic reduction such as 'raw material acquisition,' 'preparation,' 'primary production,' and 'discard'/'tool use,' corresponding to particular technical behaviours.

[792] Cf. Conard et al. (2004); see Chapter 4.

reveals the redundant nature of the structural differences, further corroborating their significance; negative is that structural redundancy paves the way for a certain monotony of analysis and argument. This monotony, however, only points to the stability of some basic patterns of reasoning, stressing their importance in the production of lithic knowledge.

From a 'formistic' point of view, 'evolution' revolves around lithic parts and consists of the selection and recombination of these parts through time. Lithic evolution is a chronological pattern of assemblage signatures; evolution, in other words, is when the aggregated part-signatures of a given set of lithic assemblages participate in a well-defined long-term pattern (cf. Chapter 3). Whether the pattern is intact or whether it is violated and, if so, at which point of the sequence is typically determined by similarity measurements. The observable evolution of technology is thought to be the product of some constant 'subsistent' category, for example social transmission, population, demography, hominin species, geography, behaviour, or cognition. Detectable ruptures in a chronological sequence of technological signatures can then be identified with changes in the otherwise constant 'subsistent' categories.

A first example is Grahame Clark's (1969) seminal pattern of five technological modes ('Mode 1-5') – recently revised into a 'Mode A-I' scheme (Shea 2013b) – that has inspired lithic scholars since its inception to propose various 'subsistent' categories in order to explain it.[793] Foley's (1987) attempt to correlate technological modes with hominin species, Mithen's (1996) proposal of cognitive evolution, and, lately, Shea's (2017a, 2017b) suggestion of evolving lithic tool dependency ('occasional' > 'obligatory' > 'habitual') represent some of the better known expressions of this research orientation.

A second example is Gilbert Tostevin's (2000, 2012) comparative lithic research of the Middle-to-Upper Palaeolithic transition in Central Europe and the Levant (Chapters 1 and 3). The decisive point is that the author analyses his lithic data in terms of a 'generational stream of social transmission,' comparing distinct lithic assemblage-signatures in order to determine whether there was continuity or discontinuity in learnt knapping behaviours. The three basic hypotheses he is testing against the lithic data ('Innovation,' 'Diffusion,' 'Combination') are refinements of the similarity/dissimilarity criterion specified before.

'Adaptation' in 'formistic' lithic research is broadly defined as the co-variation between environmental and lithic patterning – some lithic 'characters,' in other words, have to consistently participate in certain environmental patterns. For this reason, adaptation is often contrasted with 'history' since the latter implies continuity in the stream of lithic evolutionary developments (verticality), whereas the former introduces a discontinuous element (horizontality) – the constant stream of lithic signatures is altered by an external force. Lithic research tends to be guided by a general interest in the 'normality' and 'abnormality' of lithic developments. Adaptation may also be considered a potent 'subsistent' category, enabling scholars to explain patterned differences among lithic parts. As a 'subsistent' category, adaptation plays an important role especially in comparative lithic research, when different environmental settings are juxtaposed in order to assess possible effects on lithic assemblage compositions.

The 'mechanistic' perspective on lithic evolution is typically 'Neo-Darwinian' and draws on various bodies of theory that have emerged in recent years under its umbrella (cf. Kuhn 2004a; Goodale and Andrefsky 2015; see Chapter 4, second part).[794] The main concern is to specify causal principles or constraints that shape lithic technological make-ups on evolutionary time scales. Evolution is defined as a bundle of underlying processes producing largely predictable patterns in lithic parts. 'Mechanistic' approaches therefore tend to author 'hard ecology' accounts of lithic evolution, identifying mechanisms such as 'selection,' 'adaptation,' and/or 'time budgeting'/'risk' as primary driving forces of lithic development.

Adaptation is conceptualised as a set of strategies to cope with particular external conditions (e.g., Bousman 1993; Kuhn 1995). This approach seeks to deduce lithic consequences from an inventory of possible behavioural strategies and to relate them to the prevailing external conditions, either in the environmental or some other non-lithic domain. Lithic technology is typically analysed as a 'derived' phenomenon brought into existence by the more basic segments of past cultural systems such as

[793] See Chapter 3 for other 'formistic' modalities of hierarchical artefact-classification.
[794] For a basic overview of concepts and approaches of evolution in archaeology, see Shennan (2008).

'mobility/settlement' or 'subsistence.'[795] The direction of adaptation – that is, what must be adapted to what – is largely preconceived and follows the 'chain of determination' that holds together reality. The 'effective' features of lithic assemblages are shown to represent adaptations to specific mobility and/or hunting strategies which, in turn, are argued to represent ecological adaptations themselves. Although lithic adaptations are thus often regarded to be mediated by some society-internal features, these features are usually reconstructed as a product of 'cultural ecology' (e.g., Binford 1962, 1972; Butzer 1971; Jochim 1998) or, alternatively, 'behavioural ecology' (e.g., Winterhalder and Smith 2000; Shea 2011b; McCall 2015). These perspectives tend to presume a great deal of 'adaptive plasticity,' allowing lithic technology to rapidly respond to new external challenges (cf. Plummer 2004; Barker et al. 2007: 259; Braun 2013: 342; Roberts et al. 2016: 314; see also Chapter 4, second part).[796]

'Contextualistic' lithic evolution is typically characterised by a chain of rather abrupt transitions between different technical contexts; each technical context ('period,' 'civilisation,' etc.) is successively re-organised to constitute a qualitatively novel context. Evolution is the recognition that some technical contexts can no longer be maintained – change is based on the simple fact that the temporal 'spread' of a context is restricted. The upshot is a tendency to picture evolution as a rather *loose succession* of distinct technical contexts in time. The passage from one context to the next corresponds to a fundamental shift in lithic technological organisation – lithic evolution is defined as the advancement from one *« logique technique »* ('technical logic') to the next. Since 'contextualistic' research, as a consequence, often advocates a discontinuous picture of the lithic past, the term 'evolution' may be replaced by concepts of 'historicity.' Evolution, one might say, is ultimately identified as a process that cultivates developmental contingency rather than necessity.

An instructive application of this logic of evolution is Renard and Ducasse's (2015) examination of the Solutrean-Badegoulian transition in Southwestern France (Chapter 5). The authors identify the Solutrean-Badegoulian succession with a total reconfiguration of human behaviour, technical or otherwise, affecting *all aspects* of past social life. They argue that the *l'homme total* ('total man') of the Developed Solutrean was fundamentally different from the *l'homme total* of the Early Badegoulian.

'Adaptation,' in 'contextualistic' inquiry, comes into focus as a *context-dependent* process. Adaptive context-dependency implies a minimally tripolar relationship between lithic technology, the 'technical milieu,' and natural environment(s). As a consequence, technological adaptation is seen as necessarily mediated by its 'technical milieu.' The latter forms the primary society-internal environment for technological existence, legislating over the possibilities of technical change with regard to external natural environments. This is the 'contextualistic' interpretation of what I have characterised as the 'not-everything-goes' stance in French lithic research. The implication is that 'technical milieus' effectively impose strong constraints on the 'malleability' of technical systems.

Moreover, since both the 'quality' and 'novelty' of a technical context result from the specific constellations of material and social resources as well as the dominant regimes of practical (*savoir-faire*) and conceptual knowledge (*connaissance*), adaptive lithic behaviour signifies the ability to muster these available resources to a society's advantage. It does not always or necessarily imply to adapt 'optimally' to any given circumstances insofar as optimality is defined simply in absolute or objective terms. Instead, technological adaptations are at best 'optimal' solutions in light of the available material and immaterial 'capital' (*sensu* Bourdieu 1979). Adaptation therefore depends on the capacity of a

---

[795] Even though influential Anglophone scholars such as Lewis Binford (1962, 1972) and David Clarke (1968) repeatedly attempted to establish a system-theoretical fundament of lithic analysis, their conceptions of 'systems' differ greatly from its counterpart in French lithic research. The main discrepancy between the two is that 'processual' system theories emphasise the *external relatedness* of system elements (i.e., 'sub-systems'), while French system thinking, inspired by cybernetics and general systems theory (*sensu* von Bertalanffy 1973), concentrates on the *internal workings* of particular bounded system elements (e.g., 'technical systems'). Relating these working system elements to one another is merely of secondary importance. Binford's theory of cultural systems, by contrast, was explicitly motivated by Julien Steward's (1937, 1955, 1968) theory of cultural ecology, in which cultural systems are analysed in terms of their functional relationships with environmental systems (cf. Flannery 1968). Whether the environment can be identified as a part of the same systemic whole as human society remains an open question for many French scholars and is typically seen with scepticism. Since French research rests on a 'synthetic' footing and the identification of wholes therefore precedes the specification of part-significances, the exclusion of the natural environment from the primary systemic context of human society weighs heavy.

[796] An interesting case in point is Roberts' (2016) notion of technological 'metaplasticitiy,' borrowed from Malafouris (2010) 'material engagement theory.' The author, opposing the dominant 'behavioural modernity' narrative, argues that human cognition is exceptionally plastic and therefore able to deal with all sorts of environmental conditions. This trail of reasoning leads Roberts (2016: 11f., 15-17) to conclude that material culture, including lithic technology, is highly sensitive to its ecological framing, re-casting 'metaplasticity' in terms of environmental tethering. The result is a reversal of the arrow of determination from cognition to environment but the link between the two remains foundational.

'technical milieu' to innovate – 'adaptation' and 'innovation' are not necessarily antagonistic concepts as in 'mechanism.'[797] Technical adaptation, strictly speaking, is conceived of primarily as an *inward* directed procedure – a conception also reflected in the tenet that 'a tool is primarily adapted to its gesture or mode of action' and only secondarily to its function (Leroi-Gourhan 1968; Haudricourt 1987).

From the vantage point of 'organicism,' lithic evolution is a directed, irreversible process through which the technical 'ideal' of a whole becomes manifest in step-wise fashion. Evolution happens because inconsistencies and conflicts between lithic parts have to be resolved by long-term organic processes; evolution happens until each part has been fully integrated into its associated structural whole. As shown in the second part of Chapter 5, lithic 'organicism' advertises a conception of evolution in which 'creativity' and developmental 'potentiality' are put centre stage. Although evolution is regarded as a determinative process, the nature of determination can only be *diagnosed in retrospect*, after having analysed and understood the becoming of a 'significant' whole. Radical evolutionary continuity is opposed and imperfectability and disharmony are stressed; evolution is pictured as a complex attempt to find new ways of coordinating old lithic parts to create something new; evolutionary continuity is guaranteed only insofar as each substantial evolutionary novelty inaugurates a new developmental 'stage' which is determined by its preceding 'stage' and coevally determines its succeeding 'stage.'

The result is a tendency to recognise *multiple temporalities* of change and *object-specific patterns* of evolutionary becoming (see Chapter 5, second part). This configuration either leads to the reconstruction of lithic evolution *sui generis* – as a 'quasi-living' force in its own right, potentially propelled by domain-specific principles of development and change – or the identification of lithic trajectories as *active* participants in a 'civilising process' (*sensu* Elias 1969 [1939]). Lithic evolution, in this latter view, is a part of the social evolutionary struggle to cultivate and maintain human *« civilisations »*. This process focalises the evolutionary fact of 'society-in-the-making' and pays primary attention to the at times conflict-driven articulation of *sociogenesis*, *psychogenesis*, and *technogenesis*.[798]

A good example of scrutinising creative lithic evolution *sui generis* is Boëda's (1997, 2005, 2013) inquiry into 'technical lineages' (*lignées techniques*) of the earlier part of the European and Near Eastern Palaeolithic (Chapter 5, second part). The author identifies a number of distinct 'families' of technical objects (i.e. f*açonnage* or *débtiage* systems), discusses the technical 'status' of particular lithic objects (i.e. their relative 'staging'), and arranges these objects in an evolutionary sequence based on their degree of internal, structural integration. The evolutionary history of different regions is finally pictured as an alternation of distinct technical trajectories.

'Adaptation' in lithic 'organicism' is mainly conceptualised as *self-adaptation*. There are two complementary reasons for this: first, processes of technical evolution are likely to generate new problems while they try to find pathways of integration; the result is the ever-lurking possibility of unanticipated and 'homemade' obstacles of development. In the long-run, technical evolution consequently has to adapt *to its own past doings* and thus tends to produce technical means which not only solve but also generate problems. Secondly, the evolutionary becoming of extended technical wholes – their structural 'integration' – requires the coordination of lithic parts and the optimisation of part-interactions. This is another way of saying that all parts need to *adapt* to their specific part-environment in order to realise 'organic' wholes. Technological evolution is defined as a process of 'auto-correlation' or 'self-adaptation.' At the extreme, 'organicistic' concepts of adaptation may thus be completely self-referential, and no external entity is required to justify them. Adaptation – including

[797] The 'contextualistic' point is that they may or may not depend on each other and whether they do or not in turn depends on the larger context at hand. The relationship between 'innovation' and 'adaptation' therefore primarily poses an empirical problem, not so much a theoretical one. This logic of reasoning is *relational* and captures the regulative idea of context-dependency.
[798] According to Norbert Elias (1969 [1939]), 'civilising processes' consist of the continuous generation of social relations resulting in particular *figurations* of social agents (i.e. extended social networks). This ongoing process of social efforts is called *sociogenesis* (cf. Law 2015: 278). For Elias, the process of social becoming balances compulsion and human agency and thereby reflects the creative yet determinative nature of social evolution so characteristic for 'organicistic' conceptions. Each process of *sociogenesis*, according to Elias, is inextricably bound to a process of *psychogenesis* since socialisation has inevitable psychological implications – *psychogenesis* means the development of a 'second-nature habitus' (*idem*). This evolutionary coupling of social and psychological aptitudes mirrors the holistic conception of evolution underpinning the concept of 'civilisation.' Even though Elias himself did not elaborate on this issue, with him we can further assert that s*ociogenesis* is not only bound to a process of *psychogenesis* but also makes room for a particular *technogenesis* – it is the evolutionary concert of all three fields of becoming that ultimately characterises a specific 'civilising process.'

aspects of ‘adaptive efficiency’/‘optimality’ – may hence be conceptualised as a purely *domestic* process.

Alternatively, if lithic evolution is considered an active participant of an all-encompassing ‘civilising process,’ adaptation consists of a constant negotiation of relationships between psycho-socio-technical realities and their natural environments. The link between environment and technology, again, is *indirect* – it is always mediated by the social and psychological peculiarities of the ‘internal milieu’ created by the ‘civilising process’ (Chapter 5, second part). Natural environments merely operate “on the bark” of a society (Bon 2009: 243). In this view, the concept of technological adaptation, if used at all, mainly calls attention to the ‘catalytic’ nature of environmental impacts on evolutionary time scales. Natural environments act as *catalysts* of transformation rather than as ‘stimulants’ of the same. The specificity of a ‘catalyst’ is its largely ‘passive’ behaviour until some context-specific circumstances occur that initiate its activity (cf. Morsink 2018).[799] This tacit ‘catalytic’ conception of the role of the natural environment in human sociotechnical evolution elucidates that adaptation in lithic ‘organicism’ is typically defined by the *dialectic co-adjustment* of technology and ecology by means of an extended temporal process.[800]

Because ‘organicism’ generally emphasises evolutionary *possibilities* and creative *coups de theatre*, technological adaptation may even be considered an overly banal concept, bearing little explanatory significance. Since lithic technology is generally regarded to be ‘pregnant with possibilities,’ it is by definition *rich* in functionality – even if this potential is not always realised. The ‘functional richness’ of technical systems complicates attempts to establish one-to-one relationships between particular technical functions and specific environmental requirements. There is always an entire spectrum of varying ecological conditions under which a given technology may perform exceptionally well.[801] Most lithic technologies appear to be ‘adaptive’ for this reason alone – scrutinising technological adaptations, in turn, becomes almost redundant from this perspective.

Altogether, this synoptic confrontation of prevailing interpretations of ‘evolution’ and ‘adaptation’ demonstrates that French and Anglophone concepts mirror their world theory affiliation. The recapitulation also shows that similar terms do not need to reflect the same concepts and that similar concepts may play a different role in different cognitive environments. These differences – sometimes subtle, sometimes more substantial – are key sources of miscommunication and interpretive conflict. They illustrate what has come to define the French-Anglophone divide in lithic studies. As the synthesis has further demonstrated, the structural categories of the four world theories – ‘formism,’ ‘mechanism,’ ‘contextualism,’ and ‘organicism’ – can considerably clarify the nature of the observable discrepancies, affirming their significance for understanding the bigger picture of the French-Anglophone divide.

Finally, the identified differences also help to trace some of the internal fault lines characterising both research constellations. In the French scene, diverging conceptions of ‘evolution’ seem to animate the lasting tension between ‘neo-catastrophic’ or ‘punctuated’ perspectives on long-term lithic developments on the one hand (‘contextualism’), and ‘transformational-genetic’ perspectives on the other (‘organicism’). Within the latter, we can observe a continuing struggle about the relative primacy of *societal* (Bon 2009, 2015; Valentin 2008) and *technological* (Boëda 2005, 2013) regimes of evolution. In Anglophone lithic research, differential understandings of ‘evolution’ and ‘adaptation’ are per-

---

[799] Bon (2009: 243) explicitly characterises the natural environmental context of human social evolution as a “passive” factor of change (cf. **Appendix Q. 4**). This conception becomes only understandable, I believe, if we introduce the idea that natural environment are ‘catalysts’ of social evolution rather than its protagonist.

[800] The metaphor of the ‘catalyst’ in human-environment relations is insightfully discussed by Morsink (2018). The ‘catalytic’ view acknowledges the inductive power of environments to influence the course of human evolution but avoids an eco-deterministic conception. According to Morsink (*idem*) ‘[a] catalyser is an integral part of the process of transformation; it facilitates and accelerates courses of change without being changed itself.’ A key point is that the function or role of a ‘catalyser’ is never fixed but remains strongly determined by its context. A ‘catalyser’ therefore manipulates directionalities of change without being fully responsible for the initiated direction of evolutionary processes. From this perspective, the contribution of the natural environment tends to be subtle and less obvious than often considered.

[801] Moreover, the functional potential of lithic technology is thought to depend fundamentally on its interaction with other societal domains, including systems of mobility and subsistence; in the eyes of ‘organicistic’ inquiry, it cannot be presumed that the relationship between these domains and lithic technology is always complementary or even fully synergistic. Instead, partial conflicts, counteractions, and contradictions are at least equally possible. The functionality of lithic technology, however, depends on its own ‘integration’ into this societal whole. Considered in tandem with the general functional richness of almost any technical system, our ability to predict ‘adaptive’ lithic parameters from particular ecological conditions (and to distinguish them from ‘non-adaptive’ parameters) seems to be limited at best.

haps best expressed by the numerous heated discussions burgeoning in the aftermath of the 'Binford-Bordes debate' – when varying chronological (e.g., Mellars 1969, 1970, 1996: 315-342) and functional explanations (e.g., Freeman 1966; Binford 1973; Rolland 1977, 1981; Dibble 1984; Rolland and Dibble 1990; Dibble and Holdaway 1990) of Mousterian inter-assemblage variability famously clashed (cf. Szmid 2003), *grosso modo* reproducing the conflict between 'formism' and 'mechanism.'

6.2.3 ***The many faces of dualistic reasoning***

As a final example of the revelatory power of world hypotheses theory, we can consider the role of dualisms and conceptual dichotomies in the production and vindication of lithic knowledge. Dualistic reasoning can hardly be underestimated as an important source of conflict in lithic analysis; its example is invaluable since its changing status, to the knowledge of the author, has never been fully recognised nor investigated. Arguably, however, the many facets of dualistic reasoning open an important window into basic conceptual disparities anchoring different research projects. The ability of world hypotheses to confidently point to these differences and to help unpack them is therefore a major asset of the theory, also revealing its productivity in mapping hitherto uncharted territory.

The fact that different world theories tend to assemble different modes of dualistic reasoning is already expressed at the juncture between 'analytic' and 'synthetic' approaches. In the part-centric endeavour of 'analytic' lithic research, dualities tend to be constructed in order to relate lithic parts externally. Antipoles are hence devised to analyse their relationship in terms of similarity and correlation, or simply to infer one pole from the other. The implication is that conceptual dichotomies need to be upheld if lithic knowledge is to be gained and secured. From a 'synthetic' standpoint, by contrast, dualisms are generally invoked in order to overcome them. The objective of whole-centric lithic approaches is to either demonstrate that the dualities in question pertain to lithic parts and disappear when these parts are placed into their wholes or to show that the dichotomies help to grasp some isolated features of lithic reality but hinder the determination of lithic wholes. It therefore seems that 'synthetic' research tends to attest dualities only to tear them down again.

'Contextualistic' approaches typically examine two or more contraposing 'micro-contexts' to establish that they actually *stick together* and *co-determine* each other.[802] An example in French lithic research is the analysis of technology in terms of its 'domestic' and 'hunting' (*cynégétique*) components, regarded to be complementary but variably organised nodes of technological 'infrastructure' (see Chapter 5, first part). Alternatively, distinct 'micro-contexts' may be regarded to *mirror* each other in their configurational logic; this is usually taken as a sign of the circumstance that each fact shapes all other facts and is shaped by all of them. The holistic understanding of the *chaîne opératoire* as embodying technical, cognitive, and social facts at the same time is evidence enough for this stance. It is, nonetheless, equally reflected in many approaches that seek to interrelate lithic technology, mobility, settlement organisation, prey behaviour, and/or social values (e.g., technological valorisation) (see the first part of Chapter 5 for a number of complementary examples).

'Organicistic' lithic research identifies dualities as 'conflicts' of becoming; they are either interpreted as obstacles of evolution resolvable only in the *durée* ('duration') or as an expression of domain-specific behaviours. In the latter case, dichotomies motivate the investigation of evolutionary *self-determination* and processes of *autopoiesis*. In UTF-analysis, for example, tool-systems are analysed in terms of their internal dualisms to establish their degree of functional integration (Chapter 5, second part). Interpretive dualities are established, first, between 'form' and 'structure,' and, second, between 'structure' and 'function.' Duality indicates a lack of integration and thus comes into view as a *means* rather than an end of lithic evolution. A second *topos* of 'organicistic' thought is *co-implication*. Since 'organic' processes of becoming depend on the long-term coordination of supposedly counteracting poles, evolutionary trajectories can be interpreted as *imbrications* of these poles. A good example is Boëda's (2013) reading of 'technical lineages' (*lignées techniques*) as specific evolutionary constellations of mind and matter, materially conserving the 'lost memory' (*mémoire oubliée*) of 'fossil' societies.

[802] 'Contextualism' relies here on the 'pound-cake model' [*Rührkuchenmodell*] of cultural reality (*sensu* Hahn 2013; cf. Chapter 2; **Appendix II.3**, **Fig. II.1**).

In lithic 'formism,' duality is mainly negotiated through the analysis of part-co-variations and the mutual participation of parts in patterns of polarised domains of reality. Most commonly, however, dichotomies are interpreted as *inferential relations*. If one side of the polarity can be studied factually, the other side may be invoked as a 'subsistent' category to explain it. The mind-matter duality is regularly treated in this way. In the case of the 'handaxe debate' for example (see Chapter 4, first part), material configurations – that is, patterns and associations of lithic parts – are discussed as indications of hominin cognitive capacities. In general, this management of antithetical poles is already foreshadowed by the 'formistic' theory of cognitive criticism based on the concept of 'correspondence.' The basic strategy is to devise lithic categories (e.g., classes, types) rooted in discrete artefact features – often paying special attention to shape-related attributes – and to examine their regularities and/or patterned associations – the established categories may then be explained in light of each other. Particular 'laws of association,' specifying the inferential link between polar categories, may be discovered in this way.

'Mechanistic' approaches are the unrivalled guardians of dualistic thought – they expound an 'analytic' strategy heavily relying on 'Cartesianism.' The reasons for rejoicing polarised conceptions of worldly affairs are largely structural. All 'mechanisms' share the conviction that the 'primary' qualities of the world – categorically distinct from the 'secondary' qualities – are foundational for the latter. Similarly, dualistic reasoning in 'mechanism' is motivated by the ambition to bridge 'observable' and 'unobservable' features of reality and to neatly discriminate between 'theory' and 'data' (see Chapter 3).

The classic 'mind-body' duality, for instance, is often reconstructed as the problem of the 'effective' primary qualities of reality and their correlated, yet 'ineffective' secondary qualities (cf. **Appendix II.2**). 'Mechanists' may then infer cognitive correlates from hominin physiological or material (lithic and non-lithic) make-ups.[803] That the hominin bodies are typically re-cast in exclusively material terms is a consequence of this situation.[804] Alternatively, 'mechanistic' approaches may regard cognition as an entirely 'ineffective' category, motivating strongly 'behaviouristic' research agendas (e.g., Binford 1972: 168).[805] The fact that 'culture' is regularly dismissed as an interpretive category in lithic research similarly indicates its conceptualisation as an 'ineffective' quality in this context (cf. Kelly 2016: 20-35). The nature-culture dichotomy provides a constant incentive for discussion – whether lithic technology belongs to the realm of human nature or human culture is prominently debated (e.g., Shea 2017a; Chapter 4, second part). Another example is the basic distinction between 'style' and 'function' (e.g., Jelinek 1976; Dunnell 1978; Bettinger et al. 1996), regularly incentivising lithic scholars to consider the former as a 'derived' and hence 'ineffective' quality of past realities.[806]

The 'mechanistic' recognition of a 'laddered' structure of worldly affairs, ejecting directed causal interactions between categorically distinct domains of reality, further motivates the centralisation of lithic-nonlithic relationships (cf. Chapter 4, second part).[807] The distinction between the 'material' (lithics) and the 'social' (society) thereby often facilitates the deduction of the latter from the former by invoking some general principles of constitution. The reconstruction of specific chains of de-

[803] A prototypical example is the 'Social Brain Hypothesis' (SBH) originally developed by evolutionary psychologist Robin Dunbar (1992). SBH has recently become a major resource of sociocognitive research in the wake of Clive Gamble, John Gowlett, and others (cf. Gowlett et al. 2012; Gamble et al. 2014); it uses direct and indirect data of hominin braincases to infer neocortex ratios, which, in turn, are regarded to predict effective hominin group size (cf. Steele 1996). The latter is taken as a proxy of past social organisation and/or complexity. Although Gamble and colleagues ground their wider narratives of human evolution, including lithic technological developments, on a largely 'mechanistic' theory, their research tends to be 'formistic,' since SBH primarily serves to define the relevant 'subsistent' categories and to motivate the analysis of co-variation between hominin brain evolution and the evolution of lithic technology. For a 'mechanistic' investigation of 'finite social space' in human evolution, see e.g. the classic study by Foley and Lee (1989, 1996).

[804] Since the hominin 'body' is recognised primarily as a physical/biological entity, bodily aspects of technology, thematising for example the *social* and *technical body*, are difficult to envision for 'mechanistic' approaches. This *embodied* perspective on technological behaviour, however, is constitutive for French 'contextualistic' approaches (Chapter 5, first part). From the perspective of disciplinary history, the Anglophone focus on the 'physical body' to the expense of the 'sociotechnical body' of hominins is likely a result of the 'palaeoanthropological' heritage of major parts of Anglophone Palaeolithic archaeology, relying on intellectual exchange with both physical and biological anthropology.

[805] This 'behaviouristic' research orientation often shows itself by the rejection of what it identifies as *palaeopsychology* (cf. Conard 2009: 118).

[806] The 'Binford-Sackett debate' on the nature of lithic types in American archaeology (cf. Tostevin 2012: 29-41) exemplifies some of the tangible research consequences prompted by strictly dichotomising between 'style' and 'function.' Sackett's (1973, 1982, 1986) somewhat forgotten 'isocrestic' notion of style can be interpreted as a 'formistic' alternative to the 'mechanistic' duality between 'style' and 'function' advocated by Binford (1989) and many of his followers (see also Jelinek 1976; Dunnell 1978, 1989; Bettinger et al. 1996).

[807] 'Mechanism' relies here on the 'layer-cake model' (*Schichttortenmodell* [German]) of human reality (*sensu* Hahn 2013; cf. Chapter 2; **Appendix II.3, Fig. II.1**).

termination, for example running from the natural environment (e.g., topography, habitat structure) over mobility (e.g., site function, logistic/residential mobility) to lithic technological organisation (tool curation, cortex ratio, size distributions, raw material signatures) (e.g., Kelly 1988; Henry 1989b), illustrates this general tendency of drawing on polarised categories. 'Hard ecology' approaches to lithic technology, whether based on HBE[808] or similar research paradigms, typically rely on dualistic reasoning in this sense (see Chapter 4, second part). They make *positive* use of dichotomisation by casting reality into distinct compartments – in this way, the conceptual segregation of reality turns out to be a *precondition* for re-assembling it again. Insight literally consists of the *re-construction* of part-configurations.

As a final but highly informative aspect of the 'mechanistic' reliance on dualities, we can consider the 'problem of transition.' Dichotomisations are often used to facilitate the identification, characterisation, and/or examination of key transitions in early human evolution. Although not discussed in detail in the previous chapters, research into 'cultural' or 'behavioural modernity' relies entirely on a polarisation of research categories, resulting regularly in oppositions such as 'complexity' vs. 'non-complexity,' 'symbolic' vs. 'non-symbolic,' 'human' vs. 'primate,' 'modern' vs. 'premodern'/'archaic,' 'cultural' vs. 'biological,' and so forth. These oppositions are then charted and mapped chronologically – they are analysed in terms of an evolutionary 'field of locations.' This conceptual configuration directly motivates the quest for *origins*-questions, originally proper to 'mechanistic' thought.[809]

To conclude, the status and purpose of conceptual polarities in lithic inquiry depends on the world theory background. Similar oppositions may convey *multiple standards* of research. For instance, the duality between 'mind' (*res cogitans*) and 'matter' (*res extensa*) shows that lithic approaches under the 'analytic' banner tend to inferentially exploit dichotomies while 'synthetic' lithic research typically tries to dismantle them. It follows that lithic discussions bridging world theory boundaries, especially the 'analytic'-'synthetic' divide, and targeting concepts which participate in prominent oppositions (e.g., 'cognition,' 'complexity') may easily result in futile discussions and talking past each other.

The divergent role of conceptual dualities in the four world theories clearly hampers cross-theory communication and makes it necessary that practitioners are somewhat attentive to these differences if they wish to avoid senseless controversies. Again, some debates may be fairly 'artificial' – nothing more than *artefacts* of world theory mistranslation(s) – rather than productive or informative about the past; these debates are unlikely to contribute to the advancement of lithic knowledge. As laid bare in this section, the examination of the diversity of lithic approaches by means of world theory categories is able to track down and unpack some of these 'errant' debates.

6.3 **The epistemological status of the divide**

Having reviewed the key results of the preceding chapters, we are now in a confident position to assess their *epistemological* significance. Again, Pepper's *World Hypotheses* (1942) turns out to be an invaluable asset in this undertaking. The recognition that main tendencies in French and Anglophone lithic research can be fruitfully characterised and confronted by referring to Pepper's four-tiered framework of world theories ultimately supports the idea that the relationship between the former is of a broadly similar nature than the relationship between the latter. Drawing on Pepper's discussion of world theory relationships (Chapter 2), we can now reliably make the following assertions about the status of diverging strands in French ('contextualism' and/or 'organicism') and Anglophone ('formism' and/or 'mechanism') lithic research:

(i) their lithic knowledge claims rely on incompatible *metaphysical* theories of the world
(ii) they are *insular* and fully *autonomous*
(iii) all of them are relatively adequate, yet equally *defective* and *fallible* (each approach threatens to undermine itself)

[808] 'Human Behavioural Ecology' (see Chapter 4).
[809] See Chapter 2 for an exploration of for why especially 'consolidated' variants of 'mechanism' tend to chart structural *singularities* (cf. Chapter 2: **Box 7**).

(iv) although their scope is global, each offered perspective remains somewhat *incomplete*

(v) they are the result of a *historical* and *supra-individual* research endeavour

Assertions (i) and (ii) imply that the types of 'contextualistic,' 'formistic,' 'mechanistic,' and/or 'organicistic' perspectives on lithic technology encountered in Chapter 3 to 5 cannot be reduced to one another or translated without loss into the interpretive vocabulary provided by any of the other perspectives. Each perspective departs from disparate positive standards of lithic knowledge.[810] This also means that there is little hope to fully integrate all perspectives – to the contrary, their global integration appears rather unappealing since the cognitive originality of each perspective stems from its insularity. Although we have seen that there are tangible ways in which the four lithic perspectives can productively interact, it therefore has to be concluded that they are largely incommensurable.

Assertions (iii) and (iv) suggest that despite their great cognitive adequacy each lithic perspective faces major difficulties in ensuring its internal consistency (cf. Pepper 1935a: 370; see **Appendix II.2** for the detailed reconstruction of the basic structural predicaments) – overall, each perspective is similarly *problematic*. Since each perspective, furthermore, relies on its distinct vantage point (its 'root metaphor') and the particular standards of lithic knowledge formation and evaluation that go with it, it necessarily skews, distorts, and/or biases a part of the lithic evidence available to it. We must be prepared to acknowledge that each perspective remains somewhat fragmentary.[811] Because the relationship between the structural categories of a world theory and its evidence is reciprocal (Chapter 2), each perspective may even command *dissimilar types of lithic evidence*. With Pepper one can say that each of the alternative relatively adequate perspectives offers a 'different and irreconcilable description of the same "fact"' (*ibid*.: 371).

Furthermore, assertions (iii) and (iv) elucidate that there is *no ground* for any of the four lithic perspectives to claim cognitive superiority. In the grand scheme of things, they have to be treated as *equals* – as equally valid and equally fallible perspectives on the lithic record. Since they act as the primary, concrete positive standards of lithic knowledge (*sensu* Pepper 1942: 328), we dispose of no overarching, 'neutral' standard from which they could fairly be judged.

This last point is of critical importance since it makes unmistakably clear that the French-Anglophone divide cannot be resolved by determining which side or perspective generally offers the more promising or favourable cognitive resources. Since the various repugnant strands of lithic research draw on different world theories (*sensu* Pepper 1942), there simply is no such privileged position. We have to accept that various lithic research orientations *legitimately co-exist*. French and Anglophone lithic approaches can hence be interpreted as the product of two different socio-historical formations occupied with the development and refinement of a distinct set of equally valid research options.

Assertion (v) supports this reading and clarifies the status of world hypotheses in lithic research. World hypotheses have an existence of their own and are not just in the heads of individual scholars (cf. Pepper 1942: 115-118, 337f.) – world hypotheses entail the cumulative efforts of many generations (*ibid*.: 339).[812] Chapters 4 and 5 reinforce this view and show that different lithic researchers may participate in different cognitive projects. This fact alone might be evidence enough for the differential prolificacy of world hypotheses in lithic research. The attendance of the same researcher in the project of advancing different world hypotheses may be entirely pragmatic, strategic, and/or an outcome of changing scholarly trajectories.[813] The results are consistent with the idea that Palaeolithic

[810] Cf. Pepper (1942: 328)

[811] In Pepper's (1935a: 371) own words: "[p]resumably each [hypotheses] gives some sort of information about the world the others garble."

[812] Pepper (1942: 166) explicitly notes: "[i]t must be recalled that we make a sharp distinction between world theories and the men who develop them and write them out. The maxims of the previous chapter suggest ways by which eccentricities of authors may be separated from the development of the theories themselves. It is not what any author thinks about his theory that counts in determining its inadequacy, but what the theory itself in terms of its own logic thinks of itself."

[813] The biographic development of individual scholars sometimes leads to a change in their basic research orientation. In the French scene for example, two central figures – André Leroi-Gourhan and Éric Boëda – exemplify this possibility. Whereas Leroi-Gourhan started his scientific career with an 'organicistic' approach to human evolution and technology – the 'Early' Leroi-Gourhan of *Évolution et techniques* – and later transitioned into 'contextualistic' modes of inquiry – the 'Late' Leroi-Gourhan of *« Palethnologie »* – Boëda began his research as a Parisian 'contextualist' in the heyday of the 'technological approach' but recently turned to full-fledged lithic 'organicism' in order to understand long-term technical trajectories (Chapter 5, second part; cf. **Appendix III.4: Fig. III.5**).

archaeology represents foremost a *social* and *historical* endeavour in which varying scholarly figures may play different and at times contradictory roles.[814]

6.4 **A call for pluralism in lithic research**

Recovering the cognitive significance of the French-Anglophone divide in terms of a basic entrenchment of approaches in divergent world theories permits the recognition of *scientific pluralism* in lithic research (**Box 10**). The status of the different lithic perspectives that play a part in the divide is of such a nature that direct comparisons between data, methods, and results are considerably complicated because each perspective brings forth separate positive standards of knowledge, including its own theory of knowledge criticism and corroboration (cf. Chapters 2, 4, and 5). The cognitive value of each of the four larger orientations of lithic research – 'formism,' 'mechanism,' 'contextualism,' and 'organicism' – is defined by their unique capacity to reciprocally refine their evidence and their structural categories. The cognitive standards established to ensure the relative 'adequacy' of this process are *intrinsic* to the respective world theory orientations (Chapter 2). Since world theories are strictly insular, no common standards of knowledge criticism are readily available.

Due to this lack of common standards, conflicts and discrepancies in lithic research rooted in world theory differences can only be pointed at but are ultimately difficult to resolve. Any attempt to resolve them typically leads to one viewpoint encroaching all other perspectives. The contradictory nature of lithic knowledge claims presented in Chapter 1 and the often dissonant significations of similar research concepts summarised above are symptoms of this situation. They bespeak of viewpoints which are difficult to compare – even the same lithic 'facts,' if equally recognised, are often described in different ways. Since there is no neutral position from which these viewpoints can be judged and since all of them are based on world theories equipped with relative cognitive adequacy, no viewpoint can be discredited in principle by the others. We have to acknowledge that all of them may represent equally 'admissible' lithic standpoints.[815]

The plurality of approaches at the French-Anglophone interface gives voice to the *pluralistic condition* of lithic inquiry. This pluralism comes on two levels: there is a basic pluralism of 'analytic' and 'synthetic' approaches on the one hand, and a pluralism of 'formistic,' 'mechanistic,' 'contextualistic,' and 'organicistic' readings of the lithic record on the other. All of these perspectives stand on par with one another. With Pepper (1942: 330) we can maintain that for pragmatic reasons and matters of serious discussion none of them can be safely discarded or neglected. At the same time, all of the associated standpoints appear to be somewhat biased. Therefore we cannot elevate any and 'wish to benefit from all of their evidence, concepts, and modes of corroboration' (*idem*). Since even the standards of 'rationality' differ among these perspectives, we must be *reasonable* and treat them as equal contenders of lithic knowledge (*idem*).[816] Each perspective may tell us something about the lithic record no other perspective can. A retreat to 'scientific' appeals does not help here because each relatively adequate world theory promotes its own conception of science (Chapter 2).[817]

If we wish to avoid undesirable dogmatism, we must be mindful to the judgments and knowledge claims of *all* of the obtainable highly adequate viewpoints (cf. Pepper 1942: 342). As Pepper

---

[814] This is to say: what these individuals wanted to contribute, had hoped to achieve, or how they conceptualised their own research endeavour may not always be congruent with their *historical* contribution. Generally speaking, it is a strength of science as a collective process not to depend entirely on the dealings, intentions, and fates of its practitioners.

[815] It has to be stressed that the general admissibility of different world theory-based readings of the lithic evidence does not automatically render their knowledge contents immune to critique. The point is rather that these contents cannot simply be criticised by knowledge standards on which they do not rely in the first place. Knowledge claims must consequently be criticised *internally* – a point we will discuss in detail in the next section.

[816] Pepper (1942: 330f., 342) signifies this manoeuvre as 'post-rational eclecticism,' because rationality-standards can only be internally defined by world theories. Rationality therefore only helps us in recognising that there are multiple strands of rationality. We must hence be reasonable and accept them all as alternative positions since we wish not to miss any highly adequate judgements. Neglecting any of them would mean to fall back into dogmatism (*ibid.*: 342). Pepper (*idem*) adds: "[a]s to the objection that the weighting of the different judgements of different world theories for practical action would open the way for prejudice and caprice, the answer is that the ignoring of these diverse judgements would be still more prejudicial and capricious."

[817] The entire debate about 'scientific' and 'non-scientific' approaches (the so called 'demarcation problem;' cf. Dupré 1993) misses the point from this perspective. For the most part, this debate reflects the difficulty to navigate the 'analytic'-'synthetic' boundary and often fails to recognise that even generally shared standards of scientific conduct such as 'objectivity' are interpreted differently by different cognitive projects. What remains is a debate about the formal definition of science rather than the nature of science.

(1942: 331) rightly insists: just as we would make any other rational decision in cases of serious disagreement, we shall wish to first consult all modes of lithic knowledge before forming a final opinion (cf. Pepper 1963: 9; Stroud 2015: 284).[818] This pragmatic pluralism would require a fair and mindful engagement with the 'other' in lithic research; it presupposes a basic understanding of the 'other' and its cognitive qualities, but also entails the realisation that a 'unity' of lithic knowledge may be unattainable and undesirable. The detailed examination of the French-Anglophone divide (Chapter 3 to 5) is consistent with this conclusion. It provides strong evidence for the fact that there is much underrated *disunity* in processes of lithic knowledge formation and evaluation – a disunity that is only expected to gain in weight if other lithic research traditions are also taken into consideration.

Regarding 'disunity' as a profitable feature of lithic research and to assume a 'pluralistic stance' helps to deflect three major pitfalls (*sensu* Kellert et al. 2006: xii): (i) to marginalise and/or discount marked differences between research orientations in the hope to defend a monolithic conception of knowledge, objectivity, and/or truth; (ii) not to take sufficiently into account approaches, positions, and/or perspectives that lie outside of what is perceived as the 'mainstream;' and (iii) to greatly exaggerate the explanatory importance of approaches situated in this 'mainstream.' As shown in Chapter 1, the French-Anglophone divide exhibits at least the two last characteristics: both sides consider their own practices as 'mainstream' expressions of lithic inquiry, don't take each other's viewpoints sufficiently into account, and tend to overestimate their own interpretive importance. The first characteristic – the marginalisation of research differences – only sometimes applies (e.g., in discussions about the relationship between the *chaîne opératoire* and the 'reduction sequence').[819] It is frequently expressed, however, by the basic hesitance to quote or refer to the respective 'other.'

These and similar tendencies are troublesome since they indicate that the French-Anglophone divide creates a cognitive barrier preventing practitioners from interrogating the full spectrum of relatively adequate perspectives on the lithic record. Currently, it is not even clear whether basic research convergences with topics or interpretive trends could be recognised and synergistically exploited. Even though global convergence is difficult to conceive, partial research concurrences are clearly possible. Indeed, since we wish to base lithic knowledge on all of the disposable highly adequate perspectives we would want to be attentive for such structural convergence of insight, even if we cannot count on it. The goal must therefore be to develop strategies that help to circumvent these long-established and deeply entrenched cognitive barriers – only then is it possible to benefit from the identified diversity of lithic approaches.

The first step must be to recognise the alleged cognitive adversary as a highly competent expert. It has to be acknowledged that this adversary may well be expressing a real problem or pinpointing a blind spot in need of being addressed; one has to resist the impulse of simply obliterating non-shared viewpoints by polemical critique. Although not a simple task, the courage to respect and value opposed views is crucial for the success of pluralistic science. As sociologist Antonio Gramsci (1971: 343f., 433) convincingly argued, in intellectual disputes opponents need to be engaged where they are strongest; non-shared theoretical positions, similarly, can only be criticised if their most respected advocates are addressed (cf. Law 2015: 9).[820] In intellectual battles, there can be no easy victories since each engagement with the cognitive 'other' is both a struggle and an effort and one therefore needs to take sincerely into account what this 'other' believes and why. According to Gramsci (1971: 344, 421), only mutual reverence for different 'intellectual cultures' provides an effective remedy against ending up in a 'prison of ideologies.'[821] Disputants have to assume that their opponents are proficient scholars

[818] This point can be extended by Lakatos' (1970) important argument, originally developed to defend a pluralism of 'research programmes,' that we cannot risk to dump any rationally justified perspective since we do not know exactly what this perspective may contribute in the future. Pepper (1942: 148) clearly anticipates this argument when he insists that "[...] to sacrifice the insights into fact which any of these [world] theories give would be to sacrifice cognitive values possessing a degree of value which we have no means of estimating. For only the completely adequate world theory could provide that means."

[819] If important differences between lithic research orientations are not marginalised and/or discounted, this is often because scholars wish to level basic criticism at them (what I will identify as 'signature critique' below).

[820] Cf. "A new science proves its efficacy and vitality when it demonstrates that it is capable of confronting the great champions of the tendencies opposed to it and when it either resolves by its own means the vital questions which they have posed or demonstrates, in peremptory fashion, that these questions are false problems." (Gramsci 1971: 433).

[821] Gramsci (1971: 344) explicitly notes: "[...] [t]o understand and to evaluate realistically one's adversary's position and his reasons (and sometimes one's adversary is the whole of past thought) means precisely to be liberated from the prison of ideologies in the bad sense of the word – that of blind ideological fanaticism. It means taking up a point of view that is "critical", which for the purpose of scientific research is the only fertile one."

who have good reasons to do what they do and are largely resistant to appeals to cognitive authority or virtue.

These considerations certainly apply to the French-Anglophone divide in lithic analysis. The structured diversity of incompatible approaches justifies a pluralism of knowledge in lithic research and calls for a *bona fide* approach towards the 'other.' The 'Pepperian' reconstruction of the structure and nature of the divide puts Gramsci's reasonable considerations into nuanced perspective. The main cognitive adversaries that make their appearance at the French-Anglophone interface are different world theories. They are the principle cognitive 'others' that have to be engaged and properly addressed. The parallelisation of world theory discrepancies with the structure of the French-Anglophone divide clarifies the nature of the 'other' in lithic research and exposes the canon of conceptual resources which it exploits. The elucidation of the structural building blocks of the four principal lithic stances that contend for lithic knowledge and generate the divide (Chapters 3 to 5) therefore provides a great deal of conceptual transparency which can only promote mutual respect and understanding.

This 'Pepperian' pluralism of lithic approaches encountered at the French-Anglophone boundary is consistent with the idea of *conceptual relativity* developed by Hilary Putnam and others. Putnam (1987, 1994) persuasively argued that varying conceptual systems may turn out to be 'cognitively equivalent' – that is, strictly incompatible but nevertheless equally tenable. According to Putnam (2001), each of these systems does justice to the evidence precisely as an alternative theory – there is no independent standard forcing us to favour or select a single system to the detriment of all others. The basic contention – perfectly consistent with Pepper's reading of world theories – is that 'there exists no fact of the matter on the basis of which one could say that one description is right, and the other is wrong' (Dell'Utri 2017: 509).[822] This reiterates the insight, shared by Pepper, that there can be no impartial description of 'facts,' and equivalent cognitive systems therefore tend to report the same 'facts' in a different manner (cf. Putnam 1987: 97).

At the same time, however, it cannot be overemphasised that the idea of 'conceptual relativity' does <u>not</u> deny that scientific tenability depends on the behaviour of phenomena different from the researcher. Accepting the lurking 'conceptual relativity' of approaches does therefore <u>not</u> imply that scientific research is merely a game of conceptual schemes and/or language – conceptual relativity does not imply relativism in science (cf. Chang 2012: 261-264). Instead, we need to acknowledge that 'the nature of dependence' changes as practitioners delve into different conceptual systems (Putnam 1994: 309). This last point is crucial since it secures the circumstance that 'facts' are still *discovered* and not merely "legislated by us" (Putnam 1988: 114).

'Pepperian' world theories, interpreted as equivalent cognitive systems, are hence generally capable of interacting with the evidence creatively; they leave much leeway for the latter to shape the promoted knowledge claims, so that one rarely finds what one expects.[823] The type of pluralism that comes into view is thus not an untamed 'anarchic' relativism, but rather a moderate and reasonably constrained variant of 'multiplism' (*sensu* Krausz 1993: 4, 2007)[824] – the pragmatic refusal of the idea that to any valid question there can only be a single legitimate answer (cf. Stroud 2015).

In total, Pepper's metatheoretical framework allows us to re-cast the French-Anglophone dilemma as an epistemic opportunity. The structured diversity of equally powerful approaches defining the divide simply demonstrates that we already know a great deal about the lithic record; it also indicates how much more potential for lithic knowledge there generally is.[825] We have four highly promising strands of lithic research at our disposal; all of these different angles of inquiry are closing in upon the world of lithic technology. With Pepper (1942: 332), we may declare: "[p]aradoxically, our very insistence on the autonomy of these modes of corroboration renders their mutual cooperation clearer and more effective than it would otherwise be, for thus they cease to neutralise each other or to get in

[822] For the argument of 'cognitive equivalence,' we can also refer to Richard Bernstein's (1985: 11f.) often-cited insistence that "[t]here is no substantive overarching framework in which radically different and alternative [cognitive] schemes are commensurable."
[823] Cf. Wylie (2002: xiv).
[824] 'Multiplism' is a concept coined by art historian and philosopher of science Michael Krausz. It is the antithesis to 'singularism' which is based on the idea that knowledge is 'monolithic' and there can hence only be a single valid answer to each valid question (cf. Norton 1995). In a world of 'multiplism,' there are multiple equally admissible answers to a single valid questions and scholars face the difficulty to negotiate these answers without falling back to dogmatic positions. As Krausz (1993: 50) himself stresses, this view is consistent with a constrained relativism of scientific knowledge: "[…] incommensurability does not entail irrationality or arbitrariness."
[825] See Pepper (1942: 331f.) for the general philosophical argument.

each other's way." The identification of the fundamental pluralism of lithic approaches on the level of world theories hence enables the recognition of the 'specialised' nature of the four main lithic perspectives participating in the French-Anglophone divide.[826] None of these cognitive specialisations is dispensable if we wish to advance lithic knowledge at large. If we wish to base our knowledge on the "widest possible empirical base" (Pepper 1963: 9), we should call upon as many perspectives as possible. To paraphrase Chang (2012: 260), the aims of lithic research are overall probably better served if we hedge and cultivate multiple systems of practice.

6.5 **The art of criticism**

The pluralistic interpretation of the French-Anglophone divide in terms of 'Pepperian' world hypotheses prompts the question of cross-theory communication. Chapter 1 has shown that this aspect practically represents the sore point of French-Anglophone relations to the effect that even basal forms of cross-fertilisation are recurrently inhibited. Scholars are regularly 'lost in translation,' often without even recognising it. In this context, it has become nearly impossible to genuinely honour the 'other' as a highly competent interlocutor and to generally respect the significance of viewpoints supplied by radically different world theories. Although I do not wish to endorse the somewhat naïve conception that all miscommunication in science is harmful,[827] some types of miscommunication clearly are.

Miscommunication tends to be hazardous if cognitive 'others' are systematically misrepresented, caricaturised, and misused for *straw-men* arguments or if their cognitive achievements are rendered almost inaccessible. The first three types of miscommunication promote unnecessary hostilities towards the 'other' while the last type undermines the prospects of drawing from the full spectrum of highly adequate research perspectives. All of them are baneful, however, if we wish to cultivate a climate of 'critical practice' in which cognitive adversaries are respected for what they can do best and in which contending perspectives work each other into the ground only to become stronger.

As illustrated in Section 6.2, disastrous miscommunication between French and Anglophone lithic practitioners may be avoided if we learn to respect the cognitive architecture of contending world theories. Eliciting the nature and structure of world theories at least helps to get to some of the sources of destructive miscommunication. The key is to understand that the significance of each concept or statement put forth by a specialised cognitive framework depends on its status and function within that framework. With Pepper, we can define serious scientific miscommunication as *a defiance of the basic cognitive terms under which a concept or knowledge claim has been formed*.

Miscommunication can easily occur when basic standards of knowledge formation, evaluation, and/or corroboration collide. In this case, assertions or knowledge claims are dismantled by showing that they don't withstand one's own mode of corroboration. This sort of critique typically misses the mark because it fails to respect the cognitive terms under which the statement has been constructed.[828] Strictly speaking, the critique doesn't target the lithic assertion itself, but its repudiated world theory basis.

Another type of serious miscommunication may arise when concepts are cut off from their original cognitive environment and are transplanted into a new environment. In this case, part of the initial significance of the concept – i.e. the sum of extensional and intentional features required to do

---

[826] We therefore discover a mode of indirect interaction between the four relatively adequate world theories, authorising a loosely defined but nonetheless significant complementarity of incommensurable perspectives on the world theory level. This loosely defined complementarity can be interpreted as an expression of a basic 'cognitive division of labour,' anticipating some of the arguments brought up by later philosophers of science such as Philip Kitcher and others. Kitcher (1990, 2001) famously argued that science is successful primarily because of its *social nature*: (a) knowledge and data can easily be shared both horizontally (peers) and vertically (students); (b) scholars are able to co-develop ideas and borrow freely from each other; (c) research communities establish their own currency systems (reputation etc.) based on internalised standards of research; and (d) the social organisation of science supports a cognitive division of labour. With Pepper, we can conclude that (a) to (c) presuppose a shared world theory background whereas (d) has a dual meaning. There is 'cognitive division of labour' both *within* the boundaries of world theories and *between* distinct world theories but the function of labour-division is different in the two cases. In the first case, the way labour is divided typically reflects the relative specialisation of the theory – the internal scholarly specialisations support the overall performance of their affiliated world theory. In the second case, by contrast, division of labour is a consequence of cognitive specialisation on the world theory level. The resulting tension between scholarly specialisation and world theory specialisation further complicates cross-theory interactions.

[827] For a critique on purely functional views of scientific communication, see Coupland et al. (1991).

[828] Cf. "By the maxim of autonomy, we know that one world theory cannot be legitimately convicted of inadequacy by the judgement of another." (Pepper 1942: 115; cf. **Appendix II.2**)

its original work – may be lost. Thus, this type of miscommunication concerns the *appropriation* of research concepts. When concepts travel from one cognitive environment to another, they are typically re-interpreted in light of the structural categories proper to the new environment. Quite often, the concept is then simply reduced to its skeletal meaning in order to facilitate the transition. From the perspective of the concept's original advocates, the results frequently attest 'reductionism' and 'over-simplification.'

The prime example for the appropriation of a lithic research concept is the *chaîne opératoire*. When this concept is summoned by Anglophone scholars, it is typically recast in terms of a 'formistic' or 'mechanistic' version of the 'reduction sequence.' The *chaîne opératoire* is thereby regularly reduced to a 'field of locations' or to a generalised succession of generic and largely fixed reduction phases (cf. Sellet 1993: 106; Tostevin 2000: 62), stripping it entirely from its 'contextualistic' qualities – most notably, its 'volumetric' and 'geographic'/'topological' infrastructure.[829] Odell's (2001: 80) paradigmatic statement, already cited in Chapter 1, that '*chaîne opératoire* research is almost mystical in its ramifications' and therefore 'requires a more practical operationalisation' reflects this general attitude. Through this optic, it is not particularly surprising that specifically Anglophone researchers have tried to level the use of 'reduction sequence' and *chaîne opératoire* in lithic analysis (e.g., Shott 2003, 2007; Odell 2008: 81; *but* see Tostevin 2011b).[830] As we have seen before, this practice obstructs more than it clarifies (see Section 6.2).[831]

Another example is the French appropriation of lithic research concepts from Anglophone *design theory*. We have seen in the first part of Chapter 5 that the 'techno-economic' approach makes use of concepts initially developed by Anglophone theoretical work within the ecological paradigm. Notions such as 'versatility,' 'durability,' and/or 'maintainability' (Bleed 1986; Nelson 1991; Bamford and Bleed 1997; Kelly 2013) are deployed to shed light on 'provisioning strategies' (Kuhn 1995) and/or modalities of land-use and mobility (cf. Delagnes and Rendu 2011). The basic shared conception is that certain design features of lithic technologies are bound to specific ways of exerting these technologies in the landscape. When such concepts are incorporated into French technological approaches, however, their signification is altered. They are re-interpreted 'synthetically.' Design concepts are no longer utilised to derive correlates of lithic part-configurations, but are brought up to portray the design characteristics of technical wholes (i.e. 'Quina reduction systems,' 'Levallois reduction systems,' etc.). Design is re-cast as an emergent property of technical systems and the respective concepts are employed to capture the 'quality' of the latter (cf. Chapter 5, first part). Although this appropriation of Anglophone research concepts is *prima facie* not obstructive, it can easily lead to the misconception that French lithic experts have begun to work with original conceptual resources of the Anglo-American tradition.[832]

Miscommunication that brings down the original standards of knowledge formation raises the issue of *signature critique*. 'Signature critique' typically combines misrepresentation and caricaturisation of the 'other' with a fundamental rejection of its epistemic ideals and/or standards of inquiry. Such criticism is rather widespread and one of the most common types of scholarly engagement encountered at the French-Anglophone interface. Since the range of examples for this practice is vast, it will be discussed in some detail in the consecutive sub-section. 'Signature critique' allows us, generally speaking, to make sense of some of the basic forms of interpretive conflict defining the French-Anglophone divide in lithic research.

Although these enumerated variants of miscommunication cannot always be avoided and can sometimes be used to clarify the issues at hand or to provide creative incentives for innovation, 'critical practice' requires lithic practitioners to be somewhat attentive and reflexive about them and their possible pitfalls – the plurality of equally tenable lithic approaches cautions against the aggrandisement of

---

[829] As already outlined in Section 6.2, the most tangible effect of translating the *chaine opératoire* to a 'reduction sequence' is the de-emphasis of spatial aspects of intra-technological organisation. This de-emphasis is a consequence of the shift from artefact relationalities to 'effective' chains of artefact-causation and artefact-participations in patterns.

[830] According to Odell (2008: 81), for example, *chaîne opératoire* analysis merely delivers "warmed-over reduction sequences."

[831] To be perfectly clear, the translation of foreign research concepts into one's own structural categories may also be an important source of epistemic creativity. Conceptual exchange is therefore generally desired. We have to be aware, however, that each process of translation almost inevitably entails conceptual alteration.

[832] An example of a non-obstructive but somewhat confusing translation of ideas from French to Anglophone lithic research is the appropriation of 'techno-genetic' concepts by Michael Chazan (2016). The author adopts the notion of 'technical lineages' and re-interprets it in light of Darwinian evolutionary theory. As it becomes clear from the second part of Chapter 5, this manoeuvre substantially alters the original 'life-philosophical' signification of the concept.

one's own interpretive position. As stressed in Chapter 1, 'critical practice' implies a self-critical attitude impelling scholars to constantly monitor their contact and mode of engagement with the 'other.' Cross-theory criticism and discourse can only be successful if we recognise that different lithic approaches may base their findings on different world theories and hence respond to different 'theories of cognitive criticism' (Chapter 2; cf. Stroud 2015). A 'pluralistic stance' forbids us to simply dismiss these divergent terms. Instead, we have to learn to live with the intricacies of criticism at cognitive boundaries and the ineliminable pluralism of knowledge standards that goes with it.[833] 'Critical practice' calls for the non-dogmatic navigation of these difficulties:

> "The reality of criticism is that various interpretative communities govern the activities of their critics differently [...] there is no single way to marshal evidence and assemble critical claims. All of these activities implicate a hypothesis of the world and its structure, and out of these commitments flow ideas and methods of gathering evidence [...] The pluralism that Pepper proffers is an engaged pluralism, since it encourages flexible habits of criticism that not only strive to account for objects [...], but also realize that overly fixated commitments to one's own metaphysical stance connected to criticism could harm the social concerns that critics ought to be sensitive to." (Stroud 2015: 285)

6.5.1 ***The destructive side of signature critique***

'Signature critique' gives voice to general threads of disagreement between the four world theories. It addresses the 'regular, or traditional, difficulties found in this or that type of theory' and consequently captures many of the 'perennial problems' of Western philosophy found in textbooks and introductory chapters (Pepper 1942: 117f.). Signature critique commonly aims at 'architectural' features of non-shared worldviews (i.e. structural categories or the concepts embodying them). The critique is 'signaturesque' because we recurrently encounter the same types of criticism expressed by proponents of the same type of theory to denunciate a particular type of rival theory; the critique reassures us of the insularity of world theory positions and helps to identify the relative inadequacies of other positions.[834] Even though this capacity is not unimportant, it makes clear that signature critique must be treated with a great deal of caution. Signature critique preferentially targets the weak spots of the cognitive 'other'; it therefore sabotages any aspiration to engage the adversary where she/he is strongest. Moreover, signature critique is often levelled in order to devastate and demolish the 'other' – it frequently confesses itself guilty of 'theory-baiting' (*sensu* Law 2015: 8-10).

A second reason for the problematic status of signature critique is its effects. Rather than stimulating discussion, the fruits of advancing it are often communicative 'muteness' and 'ignorance.' The alternative seems to be an endless exchange of signature critique between two or more opposing critics. Evidently, the productivity of this undertaking is highly questionable. In general, signature critique tends to poison the climate of discussion and fosters disrespect rather than respect of the cognitive 'other.' Because it dismantles the foundations of competing viewpoints, their advocates have nothing left where they can retreat to and may thus be prepared to launch a similarly destructive counter attack. In the worst case, signature critique may therefore nurture pointless debates and imprison interactive potential (cf. Section 6.2). For these reasons, signature critique must be deployed very carefully if the pluralistic discourse is to be maintained.[835]

There are multiple variants of signature critique in the French and Anglophone expert literature. Some of these voices have already been examined in Chapter 1, but we are now in a much better position to understand their cognitive significance. Arguably, the fact that signature critique seems to permeate the French-Anglophone interface should be viewed as evidence enough for the gravity of the cognitive gulf created by the latter. The documented instances illustrate profuse stereotype-casting of

[833] Stroud (2015) argues that Pepper's 'evidentiary pluralism' enables the development of a critical yet rhetorically *engaged pluralism* (*sensu* Stroud 2014). This pluralism recognises the possibility of conceptual overlay and allows 'one to both respect and argue with other critics' and/or cognitive adversaries (Stroud 2015: 282). This pluralism allows for interaction and does not inevitably result in cognitive seclusion.

[834] A pragmatic strategy to identify 'signature critique' in applied research is therefore to compare the content of the critique with the sources of structural inadequacy in the four relatively adequate world theories (**Appendix II.2**).

[835] Although this point will not be developed here, I admit that 'signature critique' also has a positive role to play in the concert of conflicting world theories (see *supra*). As Pepper (1942: 115) himself contends, 'competent men and women' will come to agree on the basic structural inadequacies of the four different world theories and these inadequacies will likely be reflected in the main variants of 'signature critique' – even if these are dogmatically motivated. These critical voices may provide some guidance in how each position can be refined in order to more satisfactorily respond to its critics.

the cognitive 'other,' often risking to profoundly misrepresent it. We will first recapitulate the prevailing types of signature critique in the Anglophone literature before turning to the French cases.

Lack of objectivity, over-complexification, self-mover delusions, and reificationist tendencies

Anglophone researchers tend to criticise French technological research in terms of its apparent lack of 'objectivity' (e.g., Dibble 1995; Tostevin 2000: 64f.; Steenhuyse 2008: 255; Bar-Yosef and Van Peer 2009: 107f.; Scott 2011: 12)[836] and 'replicability' (Tostevin 2011b), regularly accusing *chaîne opératoire* approaches of being somewhat 'speculative' and/or relying on 'intuitive' judgement (cf. Chazan 1997; Pettitt 2003: 38; Shea 2011a: 49, 2017: 29; Monnier and Missal 2014: 61) or empathetic 'immersivity' (Odell 2008: 81). A widely-held and complementary view is that *chaîne opératoire* analysis tends to 'conflate description and interpretation' (e.g., Monnier 2009: 122; Bar-Yosef and Van Peer 2009: 124f.). As becomes clear from Chapter 3, all of these criticisms target the hallmarks of 'synthetic' modes of reasoning.

The Anglophone impression that French lithic analysis relies on "flashes of intuition" (Chazan 1997: 728) is a result of difficulties to recognise the 'synthetic' fact that technical wholes are more-than-compositional entities – 'intuition' is attested where French scholars reach out to these wholes in order to understand the signification of their parts. Likewise, the rather smooth transition between description and interpretation is simply a consequence of the 'dialectic-hermeneutic' character of analysis and argumentation in French lithic research (Chapter 3). The supposed 'immersive' quality of *chaîne opératoire* reconstructions derives from a mode of lithic knowledge production which is 'understanding-based' rather than 'explanation-based' (*idem*).[837] Since knowledge is corroborated with the help of an 'operational theory' or a 'coherence theory' of cognitive criticism (see Chapters 2 and 5) – both inconsistent with the dominant 'analytic' modes of corroboration – lithic utterances seem to lack 'objectivity.' However, strictly 'objectivist' readings of the evidence – implying generic standards of 'replicability,' 'predictability,' and the context-independent 'comparability' of lithic results (cf. esp. Tostevin 2011b: 359) – are intrinsic features only of 'analytic,' especially 'mechanistic,' research orientations. They <u>cannot</u> be seen as universally-valid standards of lithic knowledge production:

> "Critics under Pepper's scheme of criticism would realize that their practice of criticism does imply a metaphysical scheme and its standards of evidence but that this scheme is not the only decisive metaphysical scheme." (Stroud 2015: 285)

Other lines of signature critique issued by Anglophone practitioners address the purported 'over-complexification' of lithic inquiry in the French tradition (e.g., Scott 2011: 13; Shea 2013a: 154; 2017a: xvii); its Durkheimian 'obsession with self-movers' (e.g., Shennan 1993: 58), its 'essentialist' and/or 'reificationist' tendencies (e.g., Shott 2010; Tostevin 2011b: 359; Shea 2014, 2017a: 192), leading to an 'over-formalisation' of research (Bar-Yosef and Van Peer 2009); and its 'overemphasis on issues of intentionality' (e.g., McPherron 1994; Sandgathe 2004; Dibble et al. 2017; cf. Wragg Sykes 2009: 88)[838]. By taking up some of the key insights from Chapter 5, we can easily see that these charges are the consequential result of criticising 'synthetic' approaches from a self-assertive 'analytic' viewpoint.

---

[836] Cf. "[…] A technological typology is as valid as any other, but it is imperative that the characteristic products resulting from the application of the reduction methods we choose to define can be clearly identified. The validity of any typological system relies entirely on the clarity and objectivity of its classification criteria. It can be seriously questioned whether this condition is fulfilled in the [*chaîne opératoire*] approach […]." (Bar-Yosef and Van Peer 2009: 10)

[837] Pepper (1942: 100) himself points out that there is likely disagreement among world theories to what degree a fact represents a 'pure' fact directly retrieved from the word or whether it must already count as a highly 'interpreted,' i.e. cognitively digested, fact. Varying descriptions of the same 'fact' may hence entail varying interpretations about the 'purity' of the encountered fact (cf. Stroud 2015: 274). Part of the work that a world hypothesis does is to specify which sort of 'facts' directly corroborate a claim and which do not or only do so indirectly – Pepper's (1942: 48) distinction between 'data' and 'danda' serves to clear up this issue. When Anglophone practitioners depict *chaîne opératoire* approaches as yielding overly 'interpretive' accounts of the lithic evidence, this clearly indicates that both groups gauge the status and value of some 'facts' differently. The reason is of course that French researchers generally draw rather confidently on 'synthetic' lithic data while Anglophone scholars tend to concentrate exclusively on 'analytic,' part-related lithic data. For the former, the data of the latter often appear to be somewhat 'limited;' for the latter, conversely, the data of the former seem to be inherently 'subjective.'

[838] Admittedly, lithic 'intentionality' constitutes a locus of ongoing debate also among lithic 'mechanists' (the question of whether cognition has causal efficacy) and, perhaps more prominently, between lithic 'mechanists' and lithic 'formists.'

The first issue – the perceived 'over-complexification' of lithic research – has two dimensions. As we have seen in Chapters 3 and 5, French lithic research is based on an 'anti-foundational' attitude, eschewing 'reductionism' and embracing 'emergentist' perspectives on lithic technology; its strictly 'synthetic' definition of technicity favours the investigation of internal principles of technological organisation. The implicated systemic approach to lithic technology considers complexity as a key axis of analysis (see esp. Chapter 3) – 'contextualism' investigates 'textural' complexity while 'organicism' charts the complex articulation of parts and wholes in temporally-extended organic processes (see esp. Chapter 5).[839] At the same time, in 'synthetic' thought complexity is typically viewed as an ontological feature of reality, specifying how the world generally hangs together (Chapter 2). This often translates into complex ways of how the world *ought* to be reconstructed.[840] Both 'contextualism' and 'organicism' tend to steadily redefine lithic parts as wholes and wholes as parts in order to coordinate their evidence and to provide a comprehensive picture of lithic object-matters.[841] In lithic 'organicism,' as amply demonstrated by the 'techno-genetic approach' (*sensu* Boëda 1997, 2005; Chapter 5, second part), complexity easily becomes an issue of epistemology because multiple scales of analysis have to be interrelated in order to examine organic evolutionary processes. The same is true for *« Paléohistoire »* (*sensu* Valentin 2008, 2015) which explicitly seeks to integrate several evidentiary domains in the *longue durée*. Clearly, this research orientation clashes with the Anglophone insistence on the cognitive virtues of 'simplicity' (cf. e.g., Kuhn 1995; Winterhalder and Smith 2000: 52).[842]

Critique of the 'self-mover' conception reveals a similar clash of research standards. Shennan (1993: 58), for example, conveys this type of criticism by attacking the "Durkheimian insistence on explaining the social in terms of the social." Explaining the social in terms of the social sounds indeed somewhat circular from the perspective of 'analytic' science. This circularity impression, however, derives from the circumstance that 'analytic' approaches identify parts in the world and *externally relate* them in various ways to infer their wholes (Chapter 1 and 3). The resultant inclination of Anglophone lithic researchers to endorse 'externalist' explanations has been attested in Chapter 4. French 'synthetic' inquiry, however, seeks to *internally relate* parts in order to grasp technical wholes. Parts and wholes may hence be of the same kind. The result is a strong commitment to object-specifity. This orientation seems to be strongest in 'organicism' where object- and/or domain-specific behaviours create path-dependencies and conflicts of becoming (Chapter 4, second part). Since these accounts are *dynamic* rather than static, explanatory circularity is avoided.

Finally, critics who call attention to issues of 'reification' and 'over-intentionalisation' are not doing much more than pointing to some basic structural characteristics of 'synthetic' approaches. The structural categories of 'contextualism' provide a convenient means of illustration. In lithic 'contextualism,' technical wholes are analysed in terms of their 'infrastructure' ('texture') and characterised in terms of their 'quality' (see Chapter 4, first part). Since the objective is to determine what can be circumscribed as the 'immanent total meaning' of a whole, practitioners are inclined to talk about wholes in largely *qualitative* terms. The charge of 'reification' or 'essentialisation' therefore simply takes up the fact that 'contextualistic' approaches seek to isolate distinct lithic *qualities*. The related accusation that this type of lithic research often produces 'over-formalised' systems of classification misidentifies 'contextualistic' typologies as 'analytic' taxonomies[843] – 'contextualistic' classification, as shown in

[839] Shea (2013a: 154), by contrast, argues that the internal complexities of varying flaking technologies are largely irrelevant for the bigger picture of human evolution. If such complexity denotes anything, it has to do with 'culture-history' rather than with the grand schemes of the evolutionary process (*idem*). He (*ibid*.: 3) even argues that his approach is able to show that "much of the perceived complexity of the lithic archaeological record reflects archaeological theory, method, and practice, rather than the intrinsic underlying complexity of the stone tools themselves."

[840] Indirect evidence for the French tendency to champion more 'sophisticated' and 'lengthy' accounts is provided by Chapter 5 which is not just coincidentally more extensive than its Anglophone counterpart.

[841] Shea (2017a: xvii) dismisses this coordinative endeavour as a "constant tinkering" to devise "ever more complex" narratives of the human past.

[842] Pepper (1942: 147f.), anticipating this general point of friction, notes that "there is nothing that [...] a formist so enjoys as tearing down and into small pieces the "muddled" and "psychologized" logic of the organicist."

[843] The strongest critique of 'over-formalised' technological typologies to date comes from Bar-Yosef and Van Peer (2009). These authors argue that *chaîne opératoire* analysis, despite its 'often elaborate systems of description,' has largely 'failed to provide consistent definitions of its research categories' (*ibid*.: 107, 113). They further show that systematic core-refits produce divergent results from a technological 'lecture' approach (conducted by themselves!). From this comparison they conclude that *chaîne opératoire* research faces serious problems of interpretation and is often unable to reconstruct lithic technology realistically. Their paper is a good example of the real-world difficulty to navigate dissimilar standards of research. Whether their argument is valid depends entirely on the *quality* of their technological 'lecture' (i.e., on the interpretive standards they employ). They, however, base their 'lecture' on a rather simplistic examination of technological types (*ibid*.: 108-110, Fig. 2 and 3). These types

Chapter 4, is fundamentally elastic and mutable.[844] After all, it is precisely because of the inherent mutability of their interpretive categories that lithic 'contextualists' have to invest so much effort into (re-)organising their evidence.

In order to unpack the issue of 'over-intentionalisation' – or what has generally been denunciated as a practice of "chasing the rainbow" (Thomas 1986: 247) – we need to compare two extreme readings of the lithic evidence; the first is inspired by consolidated variants of 'mechanism,' the second by refined versions of 'contextualism.' From the point of view of the former, 'intention' remains a suspicious category since it may constitute a 'derived' and thus largely 'ineffective' feature of the world – 'mechanism' tends to occupy *minimalist* positions with respect to the 'intentionality' of lithic technology. The dismissive talk about *palaeopsychology* is a classic expression of this basic orientation (e.g., Binford 1972: 168). 'Mechanists' typically assume a 'materialistic' or 'behaviouristic' attitude when the question of cognition is prompted in lithic research (cf. Section 6.2).

From the perspective of refined 'contextualism,' the world is stitched together in such a way that each fact is co-fashioned by all other facts. The consequence is that all relevant categories of reality both *imbricate* and *implicate* each other.[845] This view directly leads to the classic interpretation of the *chaîne opératoire* (*sensu* Mauss, Leroi-Gourhan, Balfet, Cresswell, and Lemonnier) whose distinct materiality is thought to connote gestural, social, and cognitive aspects of human technicity alike (cf. Perlès 1991a; Bon 2009: 137f., 143). Alternatively, 'technical intentions' may be addressed by disclosing the structural principles defining the internal organisation of technical wholes. The distinction between 'structure' (*structure*), 'operation' (*fonctionnement*), and 'function' (*fonction*) – central to French technological analysis – typically serves this particular purpose (Chapter 4, first part). 'Intentionality' is therefore investigated by determining how lithic artefacts 'act in context' and how the above-mentioned structural domains of technology work together to secure distinct technical 'qualities' (see esp. first part of Chapter 4 for a detailed exposition).

Taken together, all of the presented examples can count as unambiguous instances of 'signature critique.' They confidently call into question basic pillars of alternatively tenable yet incommensurable perspectives on the lithic record. The nature and extent of defiance towards these 'other' cognitive terms suggests that the critics regard lithic scholarship as agreeable enough to populate a single discursive space. Most critics presuppose 'singularism' in lithic research (*sensu* Krausz 1993) – an assumption that is inconsistent with the practical reality of inquiry as we have seen. That different standards of research may govern different cognitive projects seems to be almost inconceivable. This is a highly unfortunate situation since the 'other,' as a result, is portrayed primarily as an inferior figure rather than a competent expert. There is thus a real danger that the pragmatic reality of disagreement becomes overshadowed by essentially dogmatic claims. Having said this, similar types of criticism can of course also be found in the French literature, but they are not as pervasive there. As stressed in Chapter 1, discussions at the French-Anglophone interface sometimes appear to be surprisingly 'sterile' and 'unilateral' – 'signature critique' is at least not as commonly levelled *in press* by French authors.[846] The few critical voices that have been printed (see Chapter 1) will be discussed in the remainder of this section.

Falling prey to hylomorphism, deus ex machina explanations, and the correlationist seduction

French scholars have traditionally criticised the interpretation of lithic typology in terms of 'taxonomy' or 'systematics' (e.g., Tixier 2012 [1978]; Perlès 1987; Valentin 1995; Boëda 1997), reaching a prelimi-

---

are clearly not developed by means of a careful analysis of artefact inter-relations, they are based on an 'objectivist' theory of types. Their classification remains 'analytic' rather than 'synthetic' (let alone 'contextualistic'). Therefore, they fail in their criticism, because they do not meet the required standards. Rather ironically, they may have even shown that 'analytic' strategies of classification rather than 'synthetic' ones have basic difficulties with capturing distinct reduction sequences. The main reason why these authors identify the *chaîne opératoire* approach as a 'typological procedure in disguise' (*ibid.*: 113) seems at least that they have re-cast 'synthetic' classification in 'analytic' terms – the 'Theory of Types' being one of the latter's classic manifestations.

[844] *Contra* Tostevin (2011b: 359)

[845] The term 'imbrication' is for example explicitly used by Pigeot (2004: 351) or Bon (2009: 213) to describe the interpretative value of *chaîne opératoire* reconstructions.

[846] French 'signature critique' is much more difficult to detect since it is often hidden in lengthy monographs and typically functions to legitimate the account or narrative developed there. We rarely encounter specialised papers dedicated to the levelling of profound 'signature critique.'

nary apex in the resolute rejection of the 'dogma of hylomorphism' (Boëda 2013: 28f., 38).[847] They have similarly come to repudiate what is perceived as *deus ex machina* explanations of Anglophone 'hard ecology' approaches (Marchand 2014: 103), placing primary emphasis on a set of determinative environmental factors to illuminate the lithic record (cf. Perlès 1993; Bon 2009: esp. 119f., 179, 182; Langlais 2010; Boëda 2013: esp. 22, 42, 178, 223, 228).[848] This line of 'signature critique' comes in many facets and includes the rebuttal of 'ahistorical,' 'passive-reactive,' and/or 'non-creative' conceptions of past hunter gatherer groups (e.g., Valentin et al. 2005; Valentin 2008; Bon 2009: 120; Valentin and Bon 2012; Marchand 2014: 100-102); the proclamation of general concerns about notions of human-environment 'autoregulation' (Langlais 2010: 103); and the tendency to ridicule the 'explanatory obsession with extra-societal and/or extra-technical forces of evolution' (e.g., Boëda et al. 2001: 27; Boëda 2005). The latest episode of this prevailing line of criticism has been ignited by leading figures of *« Paléhistoire »* currents. It expresses a growing unease with matters of 'correlationism' and fundamentally questions the cognitive value of chasing patterns of evolutionary co-variation (Valentin 1995: 791, 2008: 41; cf. Marchand 2014: 109f.) – these voices try to overturn what they recognise as the 'dogma of heteronomy' in lithic studies. Based on the findings of Chapters 3 and 4, we can quickly see that the main thrust of this critique is similarly structural and targets 'architectural' features of 'analytic' modes of lithic research.

Reading typology in terms of 'taxonomy' or 'systematics' is a logical consequence of exalting a part-centred approach to the lithic evidence. From an 'analytic' perspective, lithic 'types' are primarily descriptive devices to capture the patterned structure of reality. 'Types' may also be purely 'instrumental' but in order to be significant they must be precisely definable by a set of discrete part-features (i.e. artefact 'characters,' 'traits,' 'attributes,' etc.). The standard approach is to define lithic types 'monothetically' – as clusters of objects – or 'polythetically' – as clusters of attributes (cf. Clarke 1968: 37; McPherron 1994: 42; Gamble 2001: 54, 128-130). This cognitive orientation is strongest in 'formism' where the 'Theory of Types' (Chapter 2) motivates scholars to organise the available evidence on the basis of formal similarities between lithic parts (Chapter 4, first part). Yet we have seen that 'mechanistic' approaches equally draw on 'formistic' categories to test their hypotheses; they thus practically rely on a similar treatment of evidence. The central strategy in 'mechanism' is to isolate the categories that are 'effective,' that is, help answering specialised lithic research questions. Finally, the issue of 'hylomorphism' simply points to the 'formistic' distinction between 'existence' and 'subsistence' (Chapter 2), capturing the idea that objects are configurations of form and matter yet form and matter must be kept apart since form is 'shaped matter' and thus necessarily created by something else than matter.

The charge of 'externalism' and 'ecological determinism' touches upon the very foundations of establishing, evaluating, and corroborating knowledge claims in Anglophone lithic research. The first point is that 'analytic' inquiry is generally conducted by relating lithic parts *externally*. This not only leads to the identification of groups of parts, part-patterns, and other kinds of part-configurations, but feeds directly into the conception that categories or domains of reality – conceived as higher-level parts – also need to be externally related. In 'formism,' this is commonly captured by relating the categories of 'existence' to their 'subsistent' categories, whereas lithic 'mechanism' seeks to uncover causal relationships and to map 'secondary' qualities onto 'primary' qualities.

The talk about 'causation,' 'constraining' and/or 'triggering' factors, 'mechanisms' of change, and 'first movers' reflects this basic constitution (Chapter 4, second part). The insistence on the 'specifity of response' and the 'inevitability' of effects inaugurates a strong principle of 'heteronomy,' but since order is conceived as categorical this heteronomic constitution of reality is captured by 'ladder-like' models (see Section 6.2). The particular modes of corroboration – centred on notions of 'correspondence' and 'causal-adjustment' (Chapters 2 and 4) – characterise 'analytic' perspectives on lithic technology as creating a 'correlationist' obligation.

When French scholars like Bon (2009: 179) criticise the 'mechanical relationships' (*relations méchaniques*) that come into view in this way, their critique pigeonholes the totality of 'mechanistic' perspectives. The refusal of 'correlationism' by Valentin and others (see *supra*) is similarly one-sided. All of these critics readily dismiss structural features of perspectives they don't share, but overlook that

[847] Boëda (2013) draws explicitly from Gilbert Simondon (1964: Chapitre 1) who has presented one of the most elaborate and forceful criticisms of the Aristotelian scheme of 'hylomorphism.'
[848] For a general overview of French prudence in the face of 'environmental determinism,' see also Perlès (2016).

these perspective have cognitive merit and offer equally tenable readings of the lithic past precisely because of these features. Their critique naturally follows from the standards of the world theories they have accepted but remains 'hollow' for the cognitive other because it undermines the entirety of their knowledge base – it remains destructive rather than being constructive.

Langlais' (2010: 103) scepticism about ecological 'autoregulation' signifies a similar clash of different world theory readings. Since French 'contextualism' and 'organicism' presuppose 'disorder' and 'conflict' and consider human-environment relations as necessarily mediated by the 'technical milieu', they conclude that there must always be at least residual tension between lithic technology and natural environments (see Chapter 5, second part). Anglophone 'formism' and 'mechanism,' by contrast, typically view technology as an 'adaptive interface,' regulating the reconciliation of human societies and external ecological conditions. Binford (1962: 218, 2001), for example, promoted a systemic view of the past in which *coupled* culture-environment systems are charted – the guiding assumption is that human 'cultural systems' *directly* articulate with natural 'ecological systems.' Interpretive notions borrowed from ecological theory such as the 'human niche' (*sensu* Henry 1995; Shea 2003) have further solidified this view (cf. Kelly 2016: 29, 32).[849] Through the prism of Neo-Darwinism and evolutionary economics, the relation between organisms and their environment involves a set of *equilibrium conditions* (e.g., Collard and Foley 2002).[850] In 'mechanistic' lithic research, 'Deductive Equilibrium Methodologies' (Van Huyck et al. 1990) can consequently be utilised in order to model and predict the link between technologies, societies, and natural environments (cf. e.g., Collard et al. 2005).

All of this demonstrates that 'signature critique' is a major issue at the French-Anglophone boundary. The critique is equally devastating for both sides and there is no reason to believe that any side may emerge victorious.[851] Many of the discussion points appear to be meaningless for the cognitive 'other'; the critique misses its mark since it fails to respect alternative cognitive standards in lithic knowledge production. As the present analysis has amply demonstrated, most issues cannot even be debated on strictly empirical grounds since they strongly feed into *metaphysical quarrels* about the world and how it hangs together. The encountered 'signature critique,' therefore, tends to raise largely irresolvable issues which can easily promote partisanship, lead to overly narrow or dogmatic cross-theory interaction, and/or create a wide range of potential 'no-debates.'

6.5.2 *Implications for critical practice*

If we wish to return to meaningful and productive modes of interaction between French and Anglophone practitioners, the rhetoric of lithic criticism has to be re-considered. Practitioners need to find a way of conveying their critique without demolishing the 'other.' This at the very least requires the translation of issues into a language the other can understand. Ideally, we would want to devise critique in such a way that the 'other' is in principle able to refine their position to deflect it. The implication is therefore <u>not</u> that contending viewpoints are immunised against all critique. Pepper's world theory framework simply helps to recognise which types of critique are more likely to be productive. It offers a means to better determine 'the bearings and validity of criticisms' (Pepper 1935a: 374).

The prevailing 'signature criticism' at the French-Anglophone boundary reveals the *limits* of critical engagement. Following Scott Stroud (2015), we can enunciate that lithic practitioners need to realise these limitations and must develop a self-conscious attitude towards them. Proliferous critique can only be deployed if one is aware about its limits. Being amenable to the limits of oneself presupposes acquaintance with the cognitive proficiency of others. If we wish to base lithic knowledge on the broadest possible empirical foundation, the gates of cross-theory communication must generally be kept open. This is why 'signature critique' should be avoided whenever possible or realistic. Such cri-

[849] 'Eco-Cultural-Niche-Modelling' (ECNM) can count as a prominent expression of this 'mechanistic,' *niche-based view* of past techno-cultural realities (cf. Banks et al. 2006).

[850] The key is to understand that 'equilibrium reasoning' targets external relationships in 'analytic' research. This is important because we have seen in Chapter 5 (first part) that equilibrium considerations may also play a role in French technological analyses but are typically evoked there to comprehend the internal regulatory principles of technical systems ('texture'). 'Equilibrium reasoning' therefore tends to be 'externalist' in the Anglophone world while it is typically 'internalist' in the French tradition. In the former it is used to relate parts while in the latter it is used to understand the 'operation' (*fonctionnement*) of wholes.

[851] Since the four world theories are similarly adequate and equally fallible at the same time (cf. **Appendix II.2**), there is no independent standard available for identifying intellectual 'victories' in the first place.

tique tends to belabour and ‘ideologise’ a type of scholarly communication that is already difficult enough. ‘Signature critique’ usually opens a route of no return – it lances discursive *one-way streets* (*« cul-de-sac »*) which only lead to a cognitive nowhere. This type of criticism is thus unlikely to contribute to the substantial advancement of lithic knowledge:

> “For the sort of evidentiary pluralism enunciated here, we must find a way to engage others, and that way seems to be in pursuing criticism while realizing the limits of one’s approach. That is easier to say than to practice, of course. [...] If one must [engage in reasoned criticism] in concert with others, and if one recognizes the cognitive shortcomings to simple and forceful partisan dogmatism, then one ought to follow Pepper’s lead and find a pluralistic way to orient one’s self to the claims of self and other, even when they actually or potentially disagree.” (Stroud 2015: 288)

The pluralism of lithic approaches at the French-Anglophone boundary requires the cultivation of ‘critical practices’ that cheerfully recognise the cognitive significance of multiple equally admissible yet incompatible standards of knowledge *and* criticism. The subsequent section will take up this desideratum and sketch a possible path towards the synergetic exploitation of world theories that crosscuts the ‘analytic’-‘synthetic’ boundary.

6.6 **Future perspectives: exploiting the world hypotheses interface**

There is much to be gained at the French-Anglophone interface. The clash of incompatible but similarly tenable approaches to the lithic evidence offers perhaps a singular opportunity to bring diverging lithic perspectives into fruitful dialogue. The pluralism of lithic knowledge production epitomised by the French-Anglophone divide calls for laying dogmatic hostilities to rest and respecting cognitive ‘others’ as highly competent experts. However, a truly ‘pluralistic stance’ in lithic analysis – basically without any alternative if we wish to avert undesirable dogmatism – can only be cultivated if lithic scholarship begins to concern itself more seriously with the epistemological foundations of its diverse practices. This concern must transcend well-established cognitive boundaries and try to incorporate as many of the existing lithic approaches as possible. We cannot content ourselves with being reflexive only about ‘analytic’ research for example. The theory and epistemology of lithic analysis needs to take the full spectrum of tenable research perspectives into account. Arguably, the importance of this last point has hitherto often been overlooked. A basic reason is that the very notion of ‘science’ remains as contested as in any other field of inquiry. Through the lens of the pluralism developed here, we can recognise that scientificity can only be negotiated in maximally *inclusive* terms since its various conceptions flow out of internalised standards of lithic research, and these standards may fundamentally differ between approaches and research traditions.

Pepper’s metatheoretical framework of four equally adequate world hypotheses not only helps to clarify the sources and signification of research conflicts at the French-Anglophone boundary, it also explains why it remains so difficult to find meaningful ways of engagement and communication to bridge the divide. The organisation of lithic research into ‘synthetic’ and ‘analytic’ compartments – further subdivided either into ‘contextualistic’ and/or ‘organicistic’ strands on the French side or into ‘formistic,’ and/or ‘mechanistic’ strands on the Anglophone side – illuminates the circumstance that varying approaches respond to distinct theories of corroborative truth and cognitive criticism. Each of the four perspectives supplies itself with particular standards of inquiry not shared by the other perspectives. The negotiation of research conflicts at the French-Anglophone boundary therefore premises the positive acknowledgement of these differences. Since all of the four major angles of inquiry are capable to provide equally valuable viewpoints on the lithic record, scholars are encouraged to further cultivate and refine them. By laying bare the basic conceptual canon of the four world theory positions, Pepper’s perspective may provide critical assistance in this undertaking.

If we wish to draw from the full spectrum of lithic facts – as Pepper would clearly re-commend – lithic practitioners have to invest some effort and try to find more effective ways of learning from each other. This at least compels us to reflect about possible ways of framing cross-theory engagement more effectively. I can only advise to alleviate the intuitively strong aspiration to search for common methodological and/or theoretical research coordinates in order to bring scholars from both sides together again. In light of the present study, it seems much more promising if lithic scholars would seek out potential 'topical' *rapprochements*. A partial topical integration of French and Anglophone strands of lithic research is more likely to be successful because it can accommodate the fact that similar concepts or ideas are often put to work differently. Arguably, some axes of topical convergence are already identifiable in the expert literature.

Examples of practically pre-established meeting points are the 'design' aspects of lithic technology (Bleed, Binford, Pelegrin, Delagnes); issues of mobility and the spatial organisation of technical needs (Kelly, Binford, Kuhn, Geneste, Perlès, Bon, Marchand, Audouze, Soriano, Renard and Ducasse), 'landscape learning' (Davies, Kelly, Rockman, Mevel, Anderson et al.), the 'life-history' or 'biography' of different technical objects (Dibble, McPherron, Kuhn, Bon, Soressi, Bourguignon, Boëda), mimetics and technical borrowing (Tostevin, Roussel, Soressi), the technicity of children and the question of apprenticeship (Spikins, Nowell, Shea, Zubrow, Pigeot, Ploux, Audouze),[852] the long-term trajectories of lithic evolution (Marks, Monigal, Kuhn, Shea, Pigeot, Chevrier, Boëda), human-cognition-technology co-evolution (Gowlett, Stout et al., Pigeot, Roche, Pelegrin), and 'material pre-furnishing' or 'ecological inheritance' (Barton, Riel-Salvatore, Valentin). Since human-environment relations have lately received a lot of attention by French scholars (Marchand, Valentin, Langlais), we may add this general theme as another emerging 'trading zone' (*sensu* Galison 1997).[853] The conceptual examination of these newer French research currents indicates that 'resilience' and 'sustainability' may be considered an additional future meeting point (Chapter 5, second part).[854] All of these examples are encouraging and suggest that pragmatic topical interaction may be the way to proceed. Future epistemological work should focus on the identification of similar vectors of realised or unrealised topical overlap. Again, Pepper's optic of four world theories should provide critical guidance in this task.

Another promising future perspective may be developed out of the relative complementarity of the four major research orientations competing in the French-Anglophone divide. (These considerations are naturally abstract and remain fairly general, but they nonetheless point to the practical benefits of analysing research conflicts in terms of Pepper's four relatively adequate world hypotheses.) The idea would be to creatively make use of the core tenets of particular world theories to the advantage of other theories that do not normally profit from them. This approach is necessarily somewhat *experimental,* but it promises to unlock new facts, ideas, questions, arguments, and perhaps even entire areas of inquiry. The contention here is simply that styles of reasoning sponsored by distinct world theories can be expected to have *unique strengths* and *capacities* in spawning or refining relevant conceptual resources (cf. e.g., Chang 2012: 255).

An example in the present context is knowledge about technical 'textures' and 'qualities' supplied by lithic 'contextualism.' The respective insights may be transferred into discrete data points ('characters,' 'traits,' attributes, etc.) and then examined in terms of the categories of 'formism' and/or 'mechanism.' Interpretive concepts furnished by 'contextualism' may also be considered potential 'subsistent' categories for 'formistic' approaches. 'Mechanism' may profit from the two 'synthetic' theories by adding their insights to its list of competing hypotheses. This would help to circumvent the issue of unconceived explanatory alternatives (*sensu* Stanford 2001, 2006; cf. Chapter 1) and potentially strengthen 'mechanistic' arguments. Personally, I believe that more explicit tests of spatial (i.e., 'volumetric,' 'geographic, or 'topological') explanations of lithic intra-assemblage variability could be particularly beneficial here. 'Organicism,' on the other hand, may especially take advantage of the experimental angle of 'mechanistic' research since controlled tests under (quasi-)laboratory conditions should contribute to a better understanding of technical 'nexuses' and supplement information derived from personal knapping experience. An analogous argument can be made for the potential role of simulation in 'organicism.' Likewise, 'synthetic' lithic perspectives may borrow specific quantitative meth-

[852] See for example Shott and Tostevin's (2015: 379f.) explicit discussion of French technological concepts (*technique*, *méthode*, *savoir-faire*, *connaissance*) in the context of 'analytic' research perspectives on 'bipolar technology' around the globe.
[853] According to philosopher of science Peter Galison (1997: 783), with the help of 'trading zones' even scientists who pursue radically different research paradigms may work together and exchange ideas if they can define local coordinates of convergence: "[…] [t]wo groups can agree on rules of exchange even if they ascribe utterly different significance to the objects being exchanged; they may even disagree on the meaning of the exchange process itself. Nonetheless, the trading partners can hammer out a local coordination, despite vast global differences. In an even more sophisticated way, cultures in interaction frequently establish contact languages, systems of discourse that can vary from the most function-specific jargons, through semi-specific pidgins, to full-fledged creoles rich enough to support activities as complex as poetry and metalinguistic reflection."
[854] See Gunderson (2000) for an overview of 'resilience' research in ecology.

ods from 'analytic' research, especially 'formism,' to provide an even denser account of wholes and their 'infrastructures' (and to further back up their whole-interpretations).[855] 'Analytic' approaches, in turn, would certainly benefit from paying more attention to the interpretation of non-correlations and domain-specific behaviours.

All of these reflections suggest that an 'engaged pluralism,' if taken seriously, can greatly facilitate the advancement of lithic knowledge. Following Pepper's lead, we can hold that students of lithic analysis who aspire balanced, preferably complete, and multi-angled lithic knowledge should be receptive to all of the four world theory perspectives. Respecting the pluralistic condition of lithic knowledge and its criticism means renouncing all forms of lithic dogmatism. This is admittedly more easily said than done – the general 'evidentiary deficiencies' of the lithic record from the deep past easily foster the 'ideologisation' of research (see also Chapter 1):

> "A tendency to resort to dogmatism is particularly noticeable in situations where the supply of evidence is scarcest, which in itself should be evidence enough against such claims." (Pepper 1942: 317)

The French-Anglophone divide in lithic studies is both a blessing and a curse. The disadvantage is that the sociological and historical processes which have *consolidated* specific modes of cognition on both sides and thereby created the divide currently hamper meaningful communication and generally undermine a crossing of research perspectives. The advantage is that this 'sealing of discursive spaces' provides an immense opportunity to develop and refine alternative research orientations in a highly focussed and problem-oriented manner. We can only hope that this and other pluralisms in lithic research can be conserved.

A final but important insight seems to be that the 'analytic'-'synthetic' opposition characterising much of the French-Anglophone divide must not be a role model for lithic research at large. Scientific communities are not necessarily bound to cultivating either an 'analytic' or a 'synthetic' research agenda. Even though the distinction *makes sense* as an organisational principle at the French-Anglophone interface, alternative world theory combinations may be developed to throw light on the lithic record. Other research traditions – e.g., Italian, Spanish, German, or Russian Palaeolithic archaeology – are likely to cultivate other world theory configurations. This opens up an important comparative perspective on the conceptual foundations of varying research communities disputing the lithic evidence:

> "It is one of the most important tasks in comparative epistemology to find out how conceptions and hazy ideas pass from one thought style to another, how they emerge as spontaneously generated pre-ideas, and how they are preserved as enduring, rigid structures *[Gebilde]* owing to a kind of harmony of illusions. It is only by such a comparison and investigation of the relevant interrelations that we can begin to understand our own era." (Fleck 1979 [1935]: 28).

Only future research can map these credible alternatives and compare them with the findings of the present study. A broader comparative perspective should make it possible to assess the originality and creative potential of different world theory configurations in lithic research. This, in turn, would perhaps enable a better management of the available conceptual resources in lithic analysis.

[855] One may argue that this logic of integrating 'analytic' procedures is already recognised. Some circles of lithic research in France, especially an emerging new generation of scholars working outside of Paris, are increasingly integrating quantitative methods into their predominantly qualitative accounts. There is a real potential here to finally bring home some of the lost sons of the French tradition – François Bordes and Georges Laplace – for they may offer an affordable entry point into quantitative reasoning. The Bordeaux school with its natural history legacy may play an important role in this undertaking. It is important to note, however, that it is not likely that quantitative reasoning will assume a primary role in casting the lithic evidence in the French tradition any time soon. From the perspective of 'synthetic' research, quantitative analysis may contribute to the understanding of intra-whole configurations but it cannot help in reaching out to these wholes directly since this would simply transform lithic inquiry into an 'analytic' endeavour.

Afterword

In *World Hypotheses* (1942), Pepper openly expressed his personal inclination to regard 'mechanism' as the more potent 'analytic-integrative' world theory, and 'contextualism' as the more pregnant 'synthetic-dispersive' theory:

> "It almost seems as if the four hypotheses drew together and had a tendency to pull cognitively toward the center, as if most cognitive adequacy lay somewhere between mechanism and contextualism. This appearance is strengthened by our previous comments to the effect that formism seems to be the weaker of the analytical theories, and organicism the weaker of the synthetic theories. This leaves mechanism as the stronger analytical and integrative theory, and contextualism as the stronger synthetic and dispersive theory. We are tempted to surmise that whatever system there is in the world is of a mechanistic type, and whatever dynamic vitality, of the contextualistic sort." (Pepper 1942: 148)

This preference remained fairly intact until the end of his life and resulted in the late *Concept and Quality* (1976) where Pepper sought to fuse both theories in order to forge a fifth, more powerful world theory – 'selectivism.' Although this attempt is widely regarded to have been unsuccessful, his world theory preferences remain noteworthy and can be compared to my own impression of the pros and cons of varying world theories, as they come to view in lithic research.

I generally think that the exposition of world theory ramifications in lithic analysis shows that the role and function of world hypotheses is flexible and depends on the socio-historical context of research. Tapping into the same world theory has not always the same research effects. World hypotheses therefore shape discursive formations but are also shaped by them. The relationship between the cognitive resources provided by a world theory and the discursive context of scientific investigation is reciprocal. The consequence is that the cognitive efficacy of a world theory may differ significantly between subjects, fields, and/or disciplines. The assessment of world theories in particular scientific contexts can therefore only be successful if we take into account how they resonate with other theories and specific object-matters. Personally, I believe that the differential contribution of world theories to the establishment of productive 'discursive spaces' (*sensu* Foucault 1972) is an interesting venue of investigation. The upshot seems to be that the value of world theories depends entirely on their practical *application* and there is no reason to believe that any of them should be generally preferred to any other.

A good example is the 'synthetic'-'analytic' duality at the French-Anglophone boundary. As Pepper himself admits (see *supra*), we are inclined to assume that the ideal combination of world theories would exploit the complementary specialisation of 'analytic' and 'synthetic' stances. The French-Anglophone divide, however, demonstrates that this is only half the truth. The simplest way to maintain relative cognitive coherence within a shared discursive space is to specialise *either* in 'analytic' or in 'synthetic' reasoning. Communication is greatly facilitated if one does not need to bridge the threshold between 'analytic' and 'synthetic' thought. The 'Binford-Bordes debate' (see Chapter 1) is a classic case in point. This debate could become a proper *debate* only because 'formistic' reasoning meant something to both French and Anglo-American lithic researchers at the time. The two disputing parties, in other words, could at least agree on the basic terms of discussion.

An additional realisation is that even the 'integrative' theories may assume a different status in varying research contexts. The direct comparison of French and Anglophone lithic research at least suggests that 'mechanism' and 'organicism' play an almost inversed role in their discursive spaces. Whereas 'organicism' typically builds on 'contextualistic' data and seeks to put these into the perspective of the *durée*, 'mechanism' tends to provide basic insights for 'formism' which then interprets larger lithic data-sets based on these insights. 'Mechanism' seems to be strongest on the *micro-level* of 'integrative' analysis (experimentation, simulation, etc.) while 'organicism' appears to be strongest at the *macro-level* of 'integrative' analysis (synoptic outlook, big narratives). This, in my view, reflects the 'over-specialisation' of the former into the examination of *horizontal* relationships, and of the latter into charting *vertical* relationships.

It may be argued that the relationship between the 'dispersive' theories – 'formism' and 'contextualism' – is of a complementary nature. 'Contextualism' seems to be strongest where the object of research (e.g., assemblages, periods) can easily be defined; 'formism,' by contrast, is more proliferate in how it handles evidence and seems strongest simply where it is successful in amassing large amounts of lithic data. We may therefore conclude that the former is stronger on the *micro-level* of 'dispersive' analysis, whereas the latter is stronger on the *macro-level* of the same. It may then not surprise that in the Anglophone tradition the larger narratives about human evolution have traditionally been supplied by 'formistic' inquiry.

All of this indicates that the give and take between the various world theories is much more complex than Pepper's statement suggests – a fact that even he himself admits (cf. Pepper 1942: esp. 148). As a consequence, it is impossible to know the pros and cons of different world theories in different research contexts before one has analysed them empirically. Distinct objects of science may lend themselves to different modes of analysis and make it easier for some world theories to be successful, underscoring again that the objects of science have an important say in how they are interpreted.

This last aspect may be reflected in the average performance qualities of the different world theories in lithic research. My personal impression is that the 'integrative' theories seem to be the more inconsistent performers but for different reasons. 'Mechanism,' in my view, tends to overstate its field of application and often over-extrapolates its findings. It also becomes easily dogmatic ('Believe in this causal principle or don't do science!'). The primary source of performance inconsistency in 'organicism' is its conceptual complexity. It often makes it difficult for practitioners to transfer 'organicistic' ideas into transparent and digestible argumentations or writings. 'Organicism,' too, can become easily dogmatic and often refuses to defend itself against its critics (problem of 'initiates' and 'un-initiates').[856] The average performance of 'dispersive' lithic research appears to be more consistent; 'formism' and 'contextualism' tend to be *on average* the more reliable lithic knowledge producers.

As a final point of contention, one can consider the trade-off between epistemic risk and gain. I would argue that 'synthetic' perspectives on the lithic record typically involve higher epistemic risk since they rely more extensively on interpretive methods (Chapter 3). In exchange, the knowledge gain is often exceptionally high. 'Analytic' approaches, by contrast, typically invest a lot of resources into reducing the epistemic risk involved in lithic inquiry – some of these approaches are specifically *designed* to eliminate as much residual interpretive load as possible. This, in return, establishes the tendency to yield fairly 'shallow,' 'dull,' and sometimes somewhat 'trivial' conclusions (with the notable exception of successful prognosis). This is not to say that 'analytic' accounts are less important than 'synthetic' ones, but simply highlights the fact that they tend to be more basic and *prima facie* appear to be much less 'exciting.'[857]

The whole discussion – admittedly sometimes placed on fairly 'thin ice' – indicates that the potential of the four world theories to contribute to the advancement of lithic knowledge is fundamentally different and clearly hinges upon the dynamics of interaction with their sister theories. The give and take between world theories appears to be highly intricate and we should not presume that the final answer of putting them to practice has already been given.

[856] This hesitancy to openly defend one's own position against critics seems to be related to the theory's internal conceptual complexity. To draft a proper and poignant defence of the 'organicistic' standpoint would require the investment of much time and effort – time and effort that may be better spent through advancing one's own cause rather than justifying its basic premises.

[857] This trade-off between 'analytic' and 'synthetic' approaches, if adequate, mirrors the old dilemma of navigating 'processual' (objective-scientific) and 'post-processual' (interpretive-hermeneutic) research in British and American archaeology (e.g., Wylie 1989). In the words of Lucas (2012: 2): "[t]hat dilemma, one may recall, invoked the opposition between a safe, yet dull description of the archaeological record (artifact physics) and a more speculative, yet exciting interpretation."

FAQ – Frequently Asked Questions

The purpose of this FAQ is to take up some of the criticism possibly raised against the foregoing analysis and to clarify its implications as well as my main arguments and standpoints. The aim is to prevent misunderstandings from the start and to help readers to clearly see what is claimed or implied, and what is not. The selected range of questions cannot account for every possible spark of criticism of course, but the provided deliberations should give the reader at least a profound sense of what my answers to non-anticipated questions may have been.

Don't you think that you overrate the importance of the French-Anglophone divide in contemporary lithic studies?

Perhaps, and there are certainly different *opinions* about this issue, including my own. But these viewpoints do not matter much in the present problem-context because the question, strictly speaking, is not at stake in the study. This study was merely concerned with analysing and evaluating the nature and reality of the divide, not with demonstrating its paramount significance (see Introduction). In the same way as the mere investigation of a certain lithic collection does not imply that this collection is necessarily more important than other collections, examining the French-Anglophone divide does not imply that the divide stands for the most pressing issue in current-day lithic research. This being said, I have clearly shown that the divide has *some* significance (see esp. Chapter 6) and this fact alone is warranting.

In the end, I leave it to my readership to gauge whether the divide is important enough to keep us occupied.

Is the juxtaposition between 'French' and 'Anglophone' not problematic in itself? Aren't you rather referring to a clash between some (radical) French researchers and all the rest?

Contrary to common belief, a detailed survey of the field reveals that there are not necessarily more Anglophone scholars, especially not if one takes into account only those exclusively specialising in lithic analysis (these differences are also touched upon in in Chapter 1: pp. 21-23). In numerical terms, the two spheres are comparable enough. In addition, I do not conceive of the two poles primarily in terms of nationality. Their significance in the foregoing study is rather historical as well as sociological (see **Appendix I.1**). The circumstance that the 'Anglophone' world appears to be more permeable to scholars trained elsewhere is part of the relevant division, not a difficulty of the study itself. Positing that the category of 'Anglophone' is primarily defined negatively, that is, as 'non-French', further overlooks the many other national research traditions encountered across the Palaeolithic research landscape not included in this study. The radicality charge does also not apply since the same cognitive 'radicality' can arguably be attested to many of the examined Anglophone researchers.

Don't you distort the internal variability of lithic inquiry on both sides by foregrounding the differences between French and Anglophone approaches?

As I explain in detail in Chapters 2 and 6, it is precisely the advantage of utilizing Pepper's epistemological framework to shed light on both the dynamics of the involved external and internal relationships. World hypotheses help to explain, in other words, not only what is put at stake by the divide itself, but also what drives the respective French and Anglophone discourses and what the nature of the key debates is. A classic example is the controversial interpretation of Mousterian typological variability in the Anglophone world, initiated by Sally and Lewis Binford in the late 1960s, which, as I have shown, can profitably be reconstructed as a difficulty to consolidate 'formistic' and 'mechanistic' research perspectives (cf. Chapter 6: p. 247f.).

Does the focus on the 'divide' not downplay cross-fertilising interactions between the two sides which undoubtedly took place?

It is true that I have mainly concentrated on the dividing features throughout my analysis. The reason is that many *prima facie* similarities turn out to be delusional after careful examination; this is also why I speak of 'conceptual equivocality' in Chapter 6. Even though I regard the increasing topical convergence between French and Anglophone lithic research as an opportunity (Chapter 6: p. 263f.), this should not belie the circumstance that many terminological convergences cannot be carried through to the conceptual level. In the end, the term *chaîne opératoire*, for example, stands for different research projects and theoretical commitments on both sides (cf. Chapter 6: pp. 240-243). Similar research questions are pursued by different means and concepts are not simply borrowed but translated and adapted. I provide a number of examples for this dynamic throughout the chapters (e.g., Chapter 5: p. 184, 192 and 193 as well as the discussion of conceptual equivocality in Chapter 6: pp. 240-250). Although I do not deny the reality of cross-fertilisation at the French-Anglophone interface, my point was to elucidate that quite often, the borrowed questions, concepts, or methods develop a 'life of their own' in their new cognitive environment and are put to use in rather different ways. It is indispensable, in my view, that we recognize this dynamic and are aware of it.

As a related note, the fact that the divide is perhaps not so much seen as an important issue anymore by the participants themselves is probably an outcome of more general transformations which have affected Palaeolithic research in the last decade or so. Modern scientific practice in the field tends to be hyper-pragmatic. Fighting intellectual battles has become largely anachronistic and the focus now lies on pragmatically integrating different lines of analysis within interdisciplinary, and often international, teams of researchers. In this way, scholars may contribute to multiple papers which, strictly speaking, cannot be consolidated conceptually. This modern situation, perhaps more than before, therefore demands the careful investigation of the sociological and historical context of each scholarly production. However, this situation does not imply that epistemological differences in lithic research have become unreal, nor does it show that approaches are becoming increasingly 'pluralistic.'

Why have you not paid more attention to the careful and comprehensive *definition* of what you mean by 'lithic research'?

Because any attempt to do so would have undermined my global argument. Understandings of lithic research are just as variable as conceptions of 'technology' and 'knowledge', and it is in fact the whole point of the present study to bring to light that the four world hypotheses support divergent understandings of these notions, 'lithic research' being no exception. The relevant aspects are explicitly touched upon in Chapter 1 and discussed extensively in Chapter 6.

A pragmatic understanding of lithic research, as provided at the outset of this study (see 'Key notions'), must hence suffice as a starting point of analysis.

Why does the analysis feature allegedly Anglophone scholars who are neither English nor American?

The two spheres of scholarly practice are not defined by shared nationality or exclusively in terms of the current working environment of individuals. Rather, 'French' and 'Anglophone' simply denote 'communities of thought' (*sensu* Fleck 1935 [1979]; cf. Chapter 1) and the attribution of individual researchers is based on their early education, their intellectual legacy, their entanglement with either of the two discursive formations, and their current role and impact in the same (cf. **Appendix I.1**). The geographic mobility of scholars is simply part of the difference between the two systems of practice and thought. The various sociograms included in **Appendix I.1** further illustrate this circumstance and, among other things, allow for a comparative analysis of differential levels of intra-tradition mobility that varying socio-historical research frameworks afford.

Is it not a problem that the work of some researchers can be tied to a specific world hypothesis with relative ease, while the work of others is much more difficult to attribute to a particular canon of structural categories?

Not at all. In general, this situation simply highlights that the relationship between individual thought and collective thought is complex in science, and that research has to operate within a 'mangle of practice' (Pickering 1995). The point is that a concern with world hypotheses is a concern 'with issues, rather than men' (cf. Pepper 1942: back of the book). World hypotheses operate beyond individual preferences, motives, and convictions. Different people may contribute differently and at different times to different world hypotheses – a point that I explicitly discuss in my analysis (Chapter 6: p. 251f.); some researchers also tend to be more eclectic than others (cf. Chapter 6: pp. 238-240; see also next question). By recognising the non-identity of people and world hypotheses, I give a *place* to scholarly action and acknowledge that individuals have the capacity to make a real difference in the advancement of the cognitive systems they adopt. This also shows that individuals are not completely and utterly at the mercy of world theories – an important point if one wishes to avoid blunt reductionism.

Why this focus on individual world hypotheses? Isn't the real problem that everybody is to some extent eclectic and consequently brings to bear hybrid cognitive resources?

Yes and no. There is no doubt that research often tends to be eclectic, but it is equally true that different scholars and lager 'schools of research' borrow to varying degrees from the different world theories (cf. Chapter 2: pp. 63-67; Chapter 6: pp. 238-240; Afterword: p. 268). Many scholars even reject particular world theories – sometimes more explicitly, sometimes less explicitly. Focusing on eclecticism rather than on the guiding role of 'pure' world theories prevents us from understanding the differential effect of these theories, why individual researchers sometimes feel the need to alter their cognitive framing, and why particular world theories are so fiercely antagonised by some. I elucidate and illustrate these key aspects at various stages of my analysis.

There are two larger issues, however, which are crucial to take into consideration here. First, eclecticism is not *per se* a negative quality of thought, it is often an important locus of discovery and conceptual innovation. The combination and pseudo-integration of structural categories that eclectic approaches offer can lead to crucial re-interpretations and refinements of these categories. Similarly, new questions and methodologies may be discovered in this way. In general, eclecticism *forces* some kind of synthesis which, in turn, may unlock something new or dismantle previously unrecognised theoretical needs. Secondly, recognising the value of 'purity' with regards to world hypotheses helps to understand cognitive advances, confusions, and difficulties which would otherwise remain puzzling. Pepper's (1942) original argument was that a marriage of two counteracting 'root metaphors' would inevitably lead to some conflict among interpretive categories and thus ultimately hamper the capacity of the respective approaches to criticise their findings without self-undermining (i.e., establish what they would consider 'true' without serious internal inconsistency). Cognitive progress can hence be defined as the overcoming of intrinsic conceptual conflicts by rendering a cognitive system more and more coherent; this is also a remedy against unconstraint relativism. Hence, the more general point is that mentioned features of scientific practice, arguably, cannot be understood without invoking the notion of conceptual 'purity'.

The implication is that some cognitive resources should be reserved for refining and cultivating the structural categories of each world hypotheses. The only reason why this point was not emphasised more strongly in the analysis is that the *plurality* of world hypotheses appeared to be a more pressing concern given the current state of lithic research.

Are 'integrative' world theories mono-causal and 'dispersive' theories multi-causal?

No, this is a common misconception. The difference between 'integrative' and 'dispersive' has nothing to do with the spread of determination, let alone with 'causality' which is a concept only fully embraced by 'mechanism.' Rather, the distinction calls to attention the prejudiced structure of reality and the overall *strength* and *importance* of determination that goes along with it. Because 'integrative' theories consider the world as much stronger determined than 'dispersive' theories commonly do, the former have less trouble to regard some facts as irrelevant than the latter. Dispersivity, by contrast, especially in 'contextualism,' can imply an indecisiveness about the direction, location, and/or orderliness of determinative relationships. 'Integrative' theories may consequently be mono- and multi-causal at the same time, but they typically stress the significance of determination as well as its (temporal) structure. A classic example is provided by the interpretation of 'history' in 'contextualism' and 'organicism.' For the former, history is typically all about *contingency* and various historical contexts are regarded to co-exist or follow up on each other in rather 'loose' fashion; for the latter, by contrast, history denotes a *determinative process* during which counteracting micro-contexts are resolved into a coherent organic whole – in other words, the various historical contexts are shown to represent effective stages of long-term becoming (cf. Chapter 2).

Having said this, the recognition of multi-causality, especially paired with the notion of distributed agency, is more likely to promote 'dispersive' treatments of evidence, but this link is by no means a necessary one.

Why is the historical and inter-personal context of the invoked case studies not explicitly discussed?

Because the focus of this study was systematic, not historical (cf. e.g., Cucen 2017 for some aspects of this distinction). For relevant historical background information feeding into the selection of case studies, the reader is referred to **Appendix III.4**.

What are the implications of the promoted perspective for our understanding of disciplinary history?

Macro-historically, Pepper's perspective allows us to recognise that the French-Anglophone divide has matured only recently, i.e., between the 1960s and 1980s. Before this period of transition, both research spheres were arguably anchored in 'formistic' thought – in the French case probably complemented by a distinct 'organicistic' element. The development of the various 'New' archaeologies including *Paleoanthropology* would then trigger a marked shift towards 'mechanistic' reasoning in the Anglophone world – creating the contemporary configuration of 'formism' and 'mechanism.' The emergence of *« Ethnologie préhistoire »* and *« Technologie préhistoire »* has re-oriented lithic research in France towards 'contextualistic' inquiry – a trend that was recently supplemented by re-invigorating the 'organicistic' heritage of the 'Early' Leroi-Gourhan and others. Needless to say, this emerging 'macro-vision' of the parting of ways between French and Anglophone approaches in Palaeolithic archaeology must be further substantiated by future historical and epistemological research.

Is the division you outline not simply a reiteration of the old chasm between 'processualism' and 'post-processualism'?

No. These two labels only circumscribe theoretical and conceptual developments in the Anglophone world; although the division between 'processualism' and 'post-processualism' probably re-produces the same separation of world theories as the French-Anglophone divide, the French side has come to implement both 'contextualism' and 'organicism' in rather different ways than Anglophone 'post-processualists' have done. The central point is that 'post-processualism' should be understood as a specific *historical manifestation* of 'synthetic' thought, but is – as several French scholars have emphasised on multiple occasions – 'not bound to happen everywhere' (e.g., Coudart 1999). The polarity between 'processualism' and 'post-processualism' thus describes the internal dynamics of wider archaeological debates in the Anglophone research sphere (of course transcending the boundaries of Palaeolithic archaeology), yet fails to capture the particular dynamics characterising the discursive field of French « *Préhistoire* ». That most Anglophone lithic research retains a distinct 'processual' touch is simply owned to the fact that Palaeolithic research developed out of the respective socio-historical and intellectual substrate in the Anglophone world.

Does the advocated interpretation of the French-Anglophone divide not foster relativism and 'everything-goes' attitudes?

Only if some of the central lessons of this study are overlooked. The proposed relativism is *constrained* and *well-defined*. There is not an infinite number of tenable perspectives but only four, and each of them brings into play its own internal standards and logic of reasoning (see esp. Chapter 2). In this way, the promoted view steadfastly counters aspirations from epistemological anarchism, defusing the 'spectre of relativism' once and for all.

Does the promoted perspective not render the involved parties *immune* to critique?

No. The bottom line is merely that each of the four world hypotheses has its legit *raison d'être*. Individual approaches can still, and arguably much more effectively, criticised by calling upon the internal standards of each cognitive framework (cf. Chapter 1: p. 32; Chapter 2: p. 44f.). It is also possible to criticise approaches in terms of their eclecticism, but this point needs to demonstrated and carefully argued for. In general, there is still plenty of room for applications of particular world theories being more successful or productive than others. It is also important to stress that even though I have argued that 'signature critique' should generally be avoided, the latter often helps in identifying the more general, structural weaknesses of the four world theories (see **Appendix II.2**: esp. p. 429).

Can you give an example for a practical implication of the present study? How can scholars come up with better approaches?

The first step is to self-consciously identify where one's cognitive preference or commitment lies. Researchers can then reflect on the interpretive potentials of the associated structural categories – for instance by summoning new metaphors or fields of association – and the relationships between various categories. This should of course not be done in the abstract, but always with a particular problem-context in mind. The challenge is to pinpoint productive re-interpretations of the respective structural categories or root metaphors given particular object-matters.

Another strategy would be to search for internal conceptual admixture and/or inconsistency. An example is the idea of the ecological 'niche', which a die-hard mechanist should probably discard since the concept is 'formistic' in essence: it implies a quasi-eternal, stable place in nature that can generally be defined in terms of necessary and sufficient conditions.

As detailed in Chapter 6, however, one should not only concentrate on oneself. Other cognitive frameworks may be more productive on other cognitive frontiers. The main challenge, then, is to detect these promising concepts and to translate them in a problem-oriented manner into one's own system of practice.

What can we expect for other national or transnational research traditions?

There are two broader possibilities. Other collective entities of lithic research may be guided by different configurations of world hypotheses than those encountered at the French-Anglophone interface (cf. Chapter 6: p. 265). Alternatively, they may draw on the same world theories as French or Anglophone approaches, but have come to cultivate deviating interpretations of the respective 'root metaphors' and consequently mobilise different variants of the same structural categories or even different variants of the same theories (e.g. 'immanent' vs. 'transcendent' formism, 'discrete' vs. 'consolidated' mechanism); it is also possible that the same structural categories assume varying epistemic roles or become differentially significant for the wider cognitive project advocated. The point is that Pepper gives us the means to systematically examine these issues and to test some of the attendant expectations.

Is the analysis not self-undermining since it ultimately relies on a particular world hypothesis itself?

The implication of my analysis is indeed that there can be no neutral cognitive ground and that every viewpoint is necessarily situated. My own strategy can probably be described as 'meta-contextualistic' and I have clearly given preference to the qualitative exploration of the French-Anglophone divide. But this is not self-defeating since I deliberately acknowledge this deficiency, that my perspective is partial and probably colours the divide in a particular manner. However, this analytical choice does not preclude or curtail the investigation of the divide in other terms, e.g. by means of computational-statistical methods. My approach does not endeavour to deliver the final answer, but instead calls for further investigation – the present study is simply the beginning, not the end. This being said, I nevertheless predict that 'formistic,' 'mechanistic,' and 'organicisitic' inquiry would substantiate the nature and reality of the outlined division, even though these inquiries would of course reveal additional details and perhaps foreground other issues. Only future research can tell whether I am right or wrong.

Bibliography

Abend, G. 2006. Styles of Sociological Thought: Sociologies, Epistemologies, and the Mexican and U.S. Quest for Truth. *Sociological Theory* 24(1): 1-41.

Abramiuk, M.A. 2012. *The Foundations of Cognitive Archaeology*. Cambridge (MA): MIT Press.

Adams, W.Y., E.W. Adams 1991. *Archaeological typology and practical reality*. Cambridge: Cambridge University Press.

Adams. B., B.S. Blades (eds.) 2009. *Lithic Materials and Paleolithic Societies*. Chichester: Wiley & Sons.

Addington, L. 1986. *Lithic Illustration: Drawing Flaked Stone Artifacts for Publication*. Chicago: University of Chicago Press.

Adkins, L., R. Adkins 1989. *Archaeological Illustration*. Cambridge: Cambridge University Press.

Adler, D.S. 2002. *Late Middle Palaeolithic Patterns of Lithic Reduction, Mobility, and Land Use in the Southern Caucasus*. Unpublished Doctoral Dissertation, Harvard University.

Adler, D.S., N. Tushabramishvili 2004. Middle Palaeolithic Patterns of Settlement and Subsistence in the Southern Caucasus. In: N.J. Conard (ed.), *Settlement Dynamics of the Middle Palaeolithic and Middle Stone Age, Volume II*, pp. 91-132. Tübingen: Kerns.

Ahler, S.A. 1975. *Pattern and Variety in Extended Coalescent Lithic Technology*. Unpublished Doctoral Dissertation, University of Missouri.

Aldenderfer, M.S. 1981. Creating assemblages by computer simulation: The development and uses of ABSIM. In J. B(ed.), *Simulations in Archaeology*, pp. 67-117. Santa Fe: School for American Research Seminar Series.

Aldenderfer, M.S. 1991. The analytical engine: Computer simulation and archaeological research. In: M. Schiffer (ed.), *Archaeological Method and Theory, Vol. 3*, pp. 195-247. Tucson: University of Arizona Press.

Allemand, S. 2004. La géographie culturelle. *Sciences Humaines* 153: 54-57.

Allen, G.E. 1969. Hugo de Vries and the reception of the “mutation theory”. *Journal of the History of Biology* 2(1): 56-86.

Allen, G.E. 2005. Mechanism, vitalism and organicism in late nineteenth and twentieth-century biology: the importance of historical context. *Studies in History and Philosophy of Science Part C: Studies in History and Philosophy of Biological and Biomedical Sciences* 36(2): 261-283.

Ambrose, S.H. 1998. Late Pleistocene human population bottlenecks, volcanic winter, and differentiation of modern humans. *Journal of Human Evolution* 34(6): 623-651.

Ambrose, S.H. 2001. Paleolithic technology and human evolution. *Science* 291:1748-1753.

Ambrose, S.H. 2003. Did the super-eruption of Toba cause a human population bottleneck? Reply to Gathorne-Hardy and Harcourt-Smith. *Journal of Human Evolution* 45: 231-237.

Ambrose, S.H. 2008. Howiesons Poort lithic raw material procurement patterns and the evolution of modern human behavior: A response to Minichillo (2006). *Journal of Human Evolution* 50: 365-369.

Ambrose, S.H. 2010. Coevolution of composite-tool technology, constructive memory, and language. *Current Anthropology* 51(suppl. 1): 135-147.

Ambrose, S.H., K.G. Lorenz 1990. Social and ecological models for the Middle Stone Age in southern Africa. In: P. Mellars (ed.), *The Emergence of Modern Humans*, pp. 3-33. Edinburgh: Edinburgh University Press.

Amiot, C. 1993. Analyse technologique de l’industrie lithique de Montsaugeon (Haute- Marne). *Paléo* 5: 83-109.

Amundson, R. 2005. *The changing role of the embryo in evolutionary thought: structure and synthesis*. Cambridge: Cambridge University Press.

Anderson, L., F. Bon, J.-G. Bordes, A. Pasquini, L. Slimak, N. Teyssandier 2015. Relier des espaces, construire de nouveaux réseaux : aux origines du Protoaurignacien et des débuts du Paléolithique supérieur en Europe occidentale. In: N. Naudinot, L. Meignen, D. Binder, G. Querré (eds.), *Les systèmes de mobilités de la préhistoire au moyen âge*, pp. 57-73. Antibes: Éditions APDCA.

Anderson, M., B. Meyer, S. Olivier (eds.) 2002. *Diagrammatic representation and reasoning*. London: Springer.

Angermuller, J. 2015. *Why There Is No Poststructuralism in France. The Making of an Intellectual Generation*. Bedford: Bloomsbury Academic.

Andrefsky Jr., W. 2001. Emerging Directions in Debitage Analysis. In: W. Andrefsky Jr. (ed.), *Lithic Debitage. Context, Form, Meaning*, pp. 2-14. Salt Lake City: The University of Utah Press.

Annis,D.B. 1978. A Contextualist Theory of Epistemic Justification. *American Philosophical Quarterly* 15(3): 213-219.

Apel, K.-O. 1979. *Die Erklären:Verstehen-Kontroverse in transzendental-pragmatischer Sicht*. Frankfurt a. Main: Suhrkamp.

Archer, W., D.R. Braun 2010. Variability in bifacial technology at Elandsfontein, Western cape, South Africa: a geometric morphometric approach. *Journal of Archaeological Science* 37: 201-209.

Archer, W., P. Gunz, K.L. van Niekerk, C.S. Henshilwood, S.P. McPherron 2015. Diachronic Change within the Still Bay at Blombos Cave, South Africa. *PLoS ONE* 10(7): e0132428.

Archer, W., C.M., Pop, P, Gunz, S.P. McPherron 2016. What is Still Bay? Human biogeography and bifacial point variability. *Journal of Human Evolution* 97: 58-72.

Archer, W., C.M. Pop, Z. Rezek, S. Schlager, S.C. Lin, M. Weiss, T. Dogandžić, D. Desta, S.P. McPherron 2017. A geometric morphometric relationship predicts stone flake shape and size variability. *Archaeological and Anthropological Sciences* 36(38): 1945-1954.

Arewa, O.B. 2014. A Musical Work is A Set of Instructions. *Houston Law Review* 52(2): 467-535.

Ariew, A. 2008. Population Thinking. In: M. Ruse (ed.), *The Oxford Handbook of Philosophy of Biology*, pp. 64-86. Oxford: Oxford University Press.

Armagan, T. 2003. Small Lithic Debris Analysis. In: In: D.O. Henry (ed.), *Neanderthals in the Levant: Behavioral Organization and the Beginnings of Human Modernity*, pp. 86-106. London/New York: Continuum.

Armstrong, D.M. 2004. *Truth and Truthmakers*. Cambridge: Cambridge University Press.

Arthur, W.B. 2009. *The Nature of Technology. What It is And How It Evolves*. New York: Free Press.

Ascher, R. 1968. Time's Arrow and the Archaeology of a Contemporary Community. In: K.C. Change (ed.), *Settlement Archaeology*, pp. 42-52. Palo Alto (CA): National Press Books.

Ashton, N., J. McNabb 1994. Bifaces in perspective. In: N. Ashton, A. David (eds.), *Stories in Stone*, pp. 182-191. London: Lithic Studies Society.

Ashton, N., M.J. White 2003. Bifaces and raw material: Flexible flaking in the British Early Paleolithic. In: M. Soressi, H.L. Dibble (eds.), *Multiple Approaches to the Study of Bifacial Technologies*, pp. 109-124. Philadelphia: Museum of Archaeology and Anthropology.

Audouze, F. 1987. Des modèles et des faits : les modèles de A. Leroi-Gourhan et de L. Binford confrontés aux résultats récents. *Bulletin de la Société préhistorique française* 84(10-12): 343-352.

Audouze, F. 1999. New advances in French prehistory. *Antiquity* 73: 167-175.

Audouze, F. 2002. Leroi-Gourhan, a Philosopher of Technique and Evolution. *Journal of Archaeological Research* 10(4): 277-306.

Audouze, F. 2006. Essai de modélisation du cycle annuel de nomadisation des Magdaléniens du Bassin parisien. *Bulletin de la Société Préhistorique française* 103(4): 683-694.

Audouze, F. 2010. Spatial Organization and Domesticity at Verberie. In: E. Zubrow, F. Audouze, J.G. Enloe (eds.), *The Magdalenian Household: Unraveling Domesticity*, pp. 145-175. New York: State University of New York Press.

Audouze, F. 2013. Préface. Une trajectoire originale. In: E. Boëda, *Techno-logique & Technologie. Une Paléohistoire des objets lithiques tranchants*, pp. 15-19. Paris: @rchéo-éditions.

Audouze, F., A. Leroi-Gourhan 1981. France: A Continental Insularity. *World Archaeology* 13(2): 170-189.

Audouze, F., N. Schlanger (eds.) 2004. *Autour de l'homme. Contexte et actualité d'André Leroi-Gourhan*. Antibes: Éditions APDCA.

Audouze, F., B. Valentin 2010. A Paleohistorical Approach to Upper Paleolihic Structural Changes. In: D.J. Bolender (ed.), *Eventful Archaeologies. New Approaches to Social Transformation in the Archaeological Record*, pp. 29-47. New York: State University of New York Press.

Audouze, F., P. Bodu, C. Karlin, M. Julien, J. Pelegrin, C. Perlès 2018. Leroi-Gourhan and the *chaîne opératoire*: a response to Delage. *World Archaeology*: DOI: 10.1080/00438243.2017.1416012.

Averbouh, A. 2000. *Technologie de la matière osseuse travaillée et implications palethnologiques : l'exemple des chaînes d'exploitation du bois de cervidé chez les Magdaléniens des Pyrénées*. Unpublished Doctoral Dissertation, Université de Paris I-Sorbonne.

Averbouh, A. 2001. Methodological Specifics of the Techno-Economic Analysis of Worked Bone and Antler: Mental Refitting and Methods of Application. In: A.M. Choyke, L. Bartosiewicz (eds.), *Crafting Bone: Skeletal Technologies through Time and Space*, pp. 111-121. Oxford: Archaeopress.

Ayer, A.J. 1936. *Language, Truth and Logic*. New York (NY): Dover.

Bachelard, G. 1932. *L'Intuition de l'instant. Étude sur la Siloë de Gaston Roupnel*. Paris: Stock.

Bachelard, G. 1936. *La Dialectique de la durée*. Paris: Boivin.

Bachelard, G. 1938. *La Formation de l'esprit scientifique. Contribution à une psychoanalyse de la connaissance objective*. Paris: Vrin.

Bachellerie, F. 2011. *Quelle unité pour le Châtelperronien? Apport de l'analyse taphonomique et techno-économique des industries lithiques de trois gisements aquitains de plein air : le Basté, Bidart (Pyrénées-Atlantiques) et Canaule II (Dordogne)*. Unpublished Doctoral Dissertation, Université de Bordeaux I.

Bachellerie, F., J.-G. Bordes, A. Morala, J. Pelegrin 2007. Étude typo-technologique de remontages lithiques de Canaule II, site de plein air en Bergeracois (Creysse, Dordogne). *Paléo* 19: 259–280.

Bachellerie, F., F. Bon, L. Eizenberg, D. Henry-Gambier, V. Mourre, C. Normand, J. Pelegrin, J. Primault, R. Scandiuzzi, C. Thiébault 2011. La signature archéologique de l'activité de chasse appliquée à la comparaison des industries moustériennes, châtelperroniennes et aurignaciennes des Pyrénées : nature des équipements et fonctions des sites. In: F. Bon, S. Costamagno, N. Valdeyron (eds.), *Haltes de chasse en Préhistoire. Quelles réalités archéologiques?*, pp. 131-168. Toulouse: P@lethnologie 3.

Bader, R. 2013. Multiple Domain Supervenience for Non-Classical Mereologies. In: M. Hoeltje, B. Schnieder, A. Steinberg (eds.), *Varieties of Dependence: Ontological Dependence, Grounding, Supervenience, Response-Dependence*, pp. 347-368. Munich: Philosophia Verlag.

Badiou, A. 1988. *L'Etre et l'événement*. Paris: Seuil.

Bailey, G. 1999. Eric Higgs 1908-1976. In: T. Murray (ed.), *Encyclopedia of Archaeology: The Great Archaeologists*, pp. 531-565. 2 volumes. Santa Barbara (CA): ABC-CLIO.

Bailey, G., J. Parkington (eds.) 1988. *The archaeology of prehistoric coastlines*. Cambridge: Cambridge University Press.

Baillet, M. 2017. *Eclairage de la tracéologie lithique sur le système techno-économique nomade châtelperronien*. Unpublished Doctoral Dissertation, Université de Bordeaux I.

Balandier, G. 1974. *Anthropo-logiques*. Paris: PUF.

Balfet, H. 1975. Technologie. In: R. Cresswell (ed.), *Éléments d'ethnologie*, vol. 2, pp. 44-79. Paris: Armand Colin.

Balfet, H. (ed.) 1991. *Observer l'action technique. Des chaines opératoires pour quoi faire?* Paris: Éditions du CNRS.

Balibar, E. 'The history of truth' - Alain Badiou in French philosophy. *Radical Philosophy* 115:16-28.

Bamforth, D.B. 1986. Technological Efficiency and Stone Tool Curation. *American Antiquity* 51: 38-50.

Bamforth, D.B. 1988. *Ecology and Human Organization on the Great Plains*. New York: Plenum Press.

Bamforth, D.B. 1991. Technological Organization and Hunter-Gatherer Land-Use: A California Example. *American Anquity* 56: 216-224.

Bamforth, D.B., P. Bleed 1997. Technology, Flaked Stone Technology, and Risk. In: C.M. Barton, G.A. Clark (eds.), *Rediscovering Darwin: Evolutionary Theory in Archaeological Explanation*, pp. 109-140. Washington D.C.: American Anthropological Association.

Bang-Jensen, J., G. Gutin 2007. *Digraphs: Theory, Algorithms and Applications*. Berlin: Springer.

Banks, W.E., F. d'Errico, H.L. Dibble, L. Krishtalka, D. West, D.I. Olszewski, A. Townsend Peterson, D.G. Anderson, J.C. Gillam, A. Montet-White, M. Crucifix, C.W. Marean, M.-F. Sánchez-Goñi, B. Wolfarth, M. Vanhaeren 2006. Eco-Cultural Niche Modeling: New Tools for Reconstructing the Geography and Ecology of Past Human Populations. *PaleoAnthropology* 2006: 68-83.

Barberies, D.S. 2003. In search of an object: organicist sociology and the reality of society in *fin-de-siècle* France. *History of the Human Sciences* 16(3): 51-72.

Barker, G. (ed.) 2013. *Rainforest Foraging and Farming in Island Southeast Asia: The Archaeology of the Niah Caves, Sarawak*. Cambridge: McDonald Institute for Archaeological Research.

Barker, G. 2017. *A Tale of Three Caves: Why Was Our Species So Successful At Colonising New Environments*? Amsterdam: Negenendertigste Kroon-Voordracht.

Barker, G., R. Dennell 1976. Orbituary: Eric Higgs. *Nature* 264: 97.

Barker, G., L. Farr (eds.) 2016. *Archaeological Investigations in the Niah Caves, Sarawak*. Cambridge: McDonald Institute for Archaeological Research.

Barker, G., C. Hunt, T. Reynolds 2007. The Haua Fteah, Cyrenaica (northeast Lybia): renewed investigations of the cave and its landscape. *Lybian Studies* 38: 93-114.

Barker, P. 1977. *Techniques of Archaeological Excavation*. London: Batsford.

Barrett, J.A., P.K. Stanford 2006. Prediction. In: S. Sarkar, J. Pfeifer (eds.), *The Philosophy of Science: An Encyclopedia*, pp. 585-599. New York: Routledge.

Barthélémy, J.-H. 2015. Life and Technology: An Inquiry Into and Beyond Simondon. Translated by B. Norman. Lüneburg: meson press.

Bartlett, F. 1958. *Thinking: An experimental and social study*. New York: Basic Books.

Barton, C. M. 1988. *Lithic Variability and Middle Paleolithic Behaviour: New evidence from the Iberian Peninsula*. Oxford: British Archaeological Reports.

Barton, C.M. 1990. Beyond style and function: a view from the Middle Paleolithic. *American Anthropologist* 92(1): 57-72.

Barton, C.M., J. Riel-Salvatore 2014. The formation of lithic assemblages. *Journal of Archaeological Science* 46: 334-352.

Barton, C.M., J. Riel-Salvatore 2016. A lithic perspective on ecological dynamics in the Upper Pleistocene of Western Eurasia. In: A.P. Sullivan III, D.I. Olszewski (eds.), *Archaeological Variability and Interpretation in Global Perspective*, pp. 25-51. Boulder: University Press of Colorado.

Bar-Yosef, O. 1981. The Epi-Paleolithic complexes in the southern Levant. In: J. Chauvin, P. Sanlaville (eds.), *Prehistoric du Levant*, pp. 389-408. Paris: C.N.R.S.

Bar-Yosef, O., P. Van Peer 2009. The Chaîne Opératoire Approach in Middle Paleolithic Archaeology. *Current Anthropology* 50(1): 103-131.

Basell, L.S. 2008. Middle Stone Age (MSA) site distributions in eastern Africa and their relationship to Quaternary environmental change, refugia and the evolution of Homo sapiens. *Quaternary Science Reviews* 27: 2484-2498.

Bateson, G. 1972. *Steps to an Ecology of Mind: Collected Essays in Anthropology, Psychiatry, Evolution, and Epistemology*. Chicago: The University of Chicago Press.

Bateson, G. 1979. *Mind and Nature: A Necessary Unity*. New York: Hampton Press.

Baudrillard, J. 1968. *Le système des objets*. Paris: Gallimard.

Baumann, M. 2014. *À l'ombre des feuilles de laurier... les équipements osseux solutréens du Sud-Ouest de la France. Apports et limites des collections anciennes*. Unpublished Doctoral Dissertation, Université de Paris I-Sorbonne.

Baumler, M.F. 1987. *Core Reduction Sequences: An Analysis of Blank Production in the Middle Paleolithic of Northern Bosnia (Yugoslavia)*. Unpublished Doctoral Dissertation, University of Arizona.

Baumler, M.F. 1988. Core reduction, flake production, and the Middle Paleolithic Industry of Zobiste (Yugoslavia): In. H.L. Dibble, A. Montet-White (eds.), *Upper Pleistocene Prehistory of Western Eurasia*, pp. 255-274. Philadelphia: University Museum Press.

Baumler, M.F., J. Speth 1993. A Middle Paleolithic assemblage from Kunji Cave, Iran. In: D. Olszewski, H.L. Dibble (eds.), *The Paleolithic Prehistory of the Zagros-Taurus*, pp. 1-74. Philadelphia: University Museum Press.

Bazile, F., G. Boccaccio 2008. Le Salpêtrien ancien. Un technocomplexe épisolutréen redéfini. *Gallia Préhistoire* 50: 103-141.

Becker, G. 1976. *The Economic Approach to Human Behavior*. Chicago: University of Chicago Press.

Bednarik, R.G. 2013. *Creating the Human Past: An Epistemology of Pleistocene Archaeology*. Oxford: Archaeopress.

Behrensmeyer, A.K. 2012. Conversations with Glynn's Ghost: The Evolution of Paleolandscape Research at East Turkana. In: J. Sept, D. Pilbeam (eds.), *Casting the Net Wide: Papers in Honor of Glynn Isaac and His Approach to Human Origins Research*, pp. 21-39. Oxford: Oxbow Books.

Behrensmeyer, A.K., J. Damuth, W. DiMichele, R. Potts, H. Sues, S. Wing (eds.) 1992. *Terrestrial Ecosystems Through Time*. Chicago: University of Chicago Press.

Beltz, A.M., A.G. Wright, B.N. Sprague, P.C. Molenaar 2016. Bridging the nomothetic and idiographic approaches to the analysis of clinical data. *Assessment* 23(4): 447-458.

Bensa, A. 1996. A propos de la technologie culturelle. Entretien avec Robert Cresswell. *Genèses* 24(1): 120-136.

Benzécri, J.-P. 1976. *L'analyse des données*. Paris: Dunod.

Betti, E. 1962. *Die Hermeneutik als allgemeine Methodik der Geisteswissenschaften*. Tübingen: Mohr.

Bettinger, R.L. 1987. Archeological Approaches to Hunter-Gatherers. *Annual Review of Anthropology* 16: 121-142.

Bettinger, R.L. 1996. Neofunctionalism. In: D. Levinson, M. Ember (eds.), *Encyclopedia of Cultural Anthropology*, pp. 851-853. New York: Henry Holt.

Bettinger, R.L. 1998. Foreword. In: M. Jochim, *A Hunter-Gatherer Landscape. Southwest Germany in the Late Paleolithic and Mesolithic*, pp. v-viii. New York: Plenum Press.

Bettinger, R.L., R. Boyd, P.J. Richerson 1996. Style, Function, and Cultural Evolutionary Processes. In: H. Donald, G. Maschner (eds.), *Darwinian Archaeologies*, pp. 133-164. New York: Springer.

Bettinger, R.L., B. Winterhalder, R. McElreath 2006. A simple model of technological intensification. *Journal of Archaeological Science* 33: 538-545.

Bettinger, R.L., R. Garvey, S. Tushingham 2015. *Hunter-Gatherers: Archaeological and Evolutionary Theory*. Second Edition. New York: Springer.

Bereiziat, G. 2011. *Variabilité des comportements techniques du Dryas ancien à la fin du Bølling: analyse techno-économique comparée du matériel lithique de cinq gisements tardiglaciaires du Jura méridional*. Unpublished Doctoral Dissertation, University of Bordeaux I.

Bergmann, M. 2004. What's not wrong with foundationalism. *Philosophy and Phenomenological Research* LXVIII: 161-165.

Bergson, H. 1896 [2008]. *Matière et mémoire. Essai sur la relation du corps à l'esprit*. Paris: Alcan.

Bergson, H. 1907 [2009]. *L'Evolution créatrice*. Paris: Alcan.

Bergson, H. 1922. *Durée et simultanéité. A propos de la théorie d'Einstein*. Paris: Alcan.

Bergson, H. 1934. *La pensée et le mouvant. Essais et conférences*. Paris: Alcan.

Bergson, H. 1959. *Œuvres*. Paris: PUF.

Bernback, R. 1997. *Theorien in der Archäologie*. Tübingen: Francke.

Bernstein, R.J. 1985. *Beyond Objectivism and Relativism*. Philadelphia: University of Pennsylvania Press.

Bert, J.-F. (ed.) 2010. *Des gestes aux techniques. Essai sur les techniques dans les sociétés pré-machinistes, texte inédit d'André-Georges Haudricourt*. Paris: Éditions Quæ.

Bertalanffy, L. von 1950. An Outline of General System Theory. *The British Journal for the Philosophy of Science* 1(2): 134-165.

Bertalanffy, L. von 1973. *Théorie générale des systèmes*. Paris: Dunod.

Beven, K.J., J. Freer 2001. Equifinality, data assimilation, and uncertainty estimation in mechanistic modelling of complex environmental systems. *Journal of Hydrology* 249: 11-29.

Beyries, S., F. Joulian 1990. L'utilisation d'outils chez les animaux : chaînes opératoires et complexité technique. *Paléo* 2: 17-26.

Bickle, J. 2016. Multiple Realizability. In: E.N. Zalta (ed.), The Stanford Encyclopedia of Philosophy (Spring 2016 Edition): URL = https://plato.stanford.edu/archives/spr2016/entries/multiple-realizability/. [last access 30.07.2018]

Bidet, A. 2007. Le corps, le rythme et l'esthétique sociale chez André Leroi-Gourhan. *Techniques & Culture* 48-49: 15-38.

Bieri, P. 1992. Trying out Epiphenomenalism. *Erkenntnis* 36: 283-309.

Bigelow, J., R. Pargetter 1990. *Science and Necessity*. Cambridge: Cambridge University Press.

Binder, D., J. Pelegrin 1983. *Expérimentation sur la technologie lithique du Chasséen. Rapport de la campagne expérimentale de 1983*. Paris: Archéodrome.

Binder, D., C. Perlès (in collaboration with M.-L. Inizan, M. Lechevallier) 1990. Stratégies de gestion des outillages lithiques au Néolithique. *Paléo* 2: 257-283.

Binford, L.R. 1962. Archaeology as anthropology. *American Antiquity* 28: 217-225.

Binford, L.R. 1964. A Consideration of Archaeological Research Design. *American Antiquity* 29(4): 425-441.

Binford, L.R. 1965. Archaeological systematics and the study of the culture process. *American Antiquity* 31: 203-210.

Binford, L.R. 1968a. Some Comments on Historical versus Processual Archaeology. *Southwestern Journal of Anthropology* 24(3): 267-275.

Binford, L.R. 1968b. Post-Pleistocene adaptations. In: S.R. Binford, L.R. Binford (eds.), *New Perspectives in Archaeology*, pp. 313-341. Chicago: Aldine.

Binford, L.R. 1968c. Archaeological Perspectives. In: S.R. Binford, L.R. Binford (eds.), *New Perspectives in Archaeology*, pp. 5-32. Chicago: Aldine.

Binford, L.R. 1972. *An Archaeological Perspective*. New York: Seminar Press.

Binford, L.R. 1973. Interassemblage variability: The Mousterian and the functional argument. In: C. Renfrew (ed.), *The Explanation of Culture Change*, pp. 227-254. London: Duckworth.

Binford, L.R. (ed.) 1977. *For Theory Building in Archaeology*. New York: Academic Press.

Binford, L.R. 1978. *Nunamiut Ethnoarchaeology*. New York: Academic Press.

Binford, L.R. 1979. Organization and formation processes: looking at curated technologies. *Journal of Anthropological Research* 35: 255-273.

Binford, L.R. 1980. Willow smoke and dogs' tails: hunter-gatherer settlement systems and archaeological site formation. *American Antiquity* 45: 4-20.

Binford, L.R. 1981a. Behavioural Archaeology and the 'Pompeii Premise'. *Journal of Anthropological Research* 37: 195-208.

Binford, L.R. 1981b. *Bones. Ancient Men and Modern Myths*. Orlando: Academic Press.

Binford, L.R. 1982. Objectivity-Explanation-Archaeology. In: C. Renfrew, M.J. Rowland, B.A. Segraves (eds.), *Theory and Explanation in Archaeology*, pp. 125-138. London: Academic Press.

Binford, L.R. 1983a. *Working at Archaeology*. New York: Academic Press.

Binford, L.R. 1983b. *In Pursuit of the Past: Decoding the Archaeological Record*. Berkeley: University of California Press.

Binford, L.R. 1986. An Alyawara Day: Making Men's Knives and Beyond. *American Antiquity* 51: 547-562.

Binford, L.R. 1989. Styles of style. *Journal of Anthropological Archaeology* 8(1): 51-67.

Binford, L.R. 2001. *Constructing frames of reference. An analytical method for archaeological theory building using ethnographic and environmental data sets*. Berkeley (Los Angeles): University of California Press.

Binford, L.R. 2013. Lewis Binford, with William Rathje and Michael Shanks [Interview]. In: W.L. Rathje, M. Shanks, C. Whitmore (eds.), *Archaeology in the making. Conversations through a discipline*, pp. 7-24. New York: Routledge.

Binford, L.R. 2015 [1972]. Contemporary model building: paradigms and the current state of Palaeolithic research. In: D.L. Clarke (ed.), *Models in Archaeology*, pp. 109-155. London: Routledge.

Binford, L.R., S.R. Binford 1966. A preliminary analysis of functional variability in the Mousterian of Levallois facies. *American Anthropologist* 68: 238-295.

Binford, L.R., J.A. Sabloff 1982. Paradigms, Systematics, and Archaeology. *Journal of Anthropological Research* 38(2): 137-153.

Binford, S.R., L.R. Binford (eds.) 1968. *New Perspectives in Archaeology*. Chicago: Aldine.

Binmore, K.G. 2009. *Rational decisions*. Princeton (NJ): Princeton University Press.

Bird, A. 2010. Social Knowing: The Social Sense of 'Scientific Knowledge'. *Philosophical Perspectives* 24: 23-56.

Bird, A., E. Tobin 2018. Natural Kinds. In: E.N. Zalta (ed.), The Stanford Encyclopedia of Philosophy: URL = https://plato.stanford.edu/archives/spr2018/entries/natural-kinds/ [last access 16.07.2018].

Bird, D.W., J.F. O'Connell 2006. Behavioral Ecology and Archaeology. *Journal of Archaeological Research* 14: 143-188.

Blades, B.S. 1997. *Environment, Lithic Economy, and Mobility during Aurignacian Occupation of the Lower Vézère Valley in France*. Doctoral Dissertation, New York University.

[Blades, B.S. 2001. *Aurignacian Lithic Economy: Ecological Perspectives from Southwestern France*. New York: Kluwer Academic/Plenum Publishers.]

Blades, B.S. 1999. Aurignacian lithic economy and early modern human mobility: new perspectives from classic sites in the Vézère valley of France. *Journal of Human Evolution* 37: 91-120.

Blades, B.S. 2003. Endscraper reduction and hunter-gatherer mobility. *American Antiquity* 68: 141-156.

Blades, B.S. 2009. Aurignacian Core Reduction and Landscape Utilization at La Ferrassie, France. In: B. Adams, B.S. Blades (eds.), *Lithic Materials and Paleolithic Societies*, pp. 186-195. Chichester: Willey-Blackwell.

Blair, J.A., R.H. Johnson 1987. Argumentation as dialectical. *Argumentation* 1(1): 41-56.

Blanshard, B. 1939. *The Nature of Thought*. London: George Allen and Unwin.

Bleed, P. 1986. The optimal design of hunting weapons: maintainability or reliability. *American Antiquity* 51(4): 737-747.

Bleed, P. 1997. Content as variability, result as selection: Toward a behavioral definition of technology. *Archeological Papers of the American Anthropological Association* 7(1): 95-104.

Bleed, P. 2001. Trees or Chaines, Links or Branches: Conceptual Alternatives for Consideration of Stone Tool Production and Other Sequential Activities. *Journal of Archaeological Method and Theory* 8(1): 101-127.

Bleed, P., M. Douglass, A. Sumner, M. Behrendt, A. Mackay 2017. Photogrammetrical Assessment of Procedural Patterns and Sequential Structure in "Handaxe" Manufacture: A Case Study along the Doring River of South Africa. *Lithic Technology* 42(1): 1-11.

Block, F., M. Somers 1984. Beyond the economistic fallacy: the holistic social science of Karl Polanyi. In: T. Skocpol (ed.), *Vision and method in historical sociology*, pp. 47-84. Cambridge: Cambridge University Press.

Blumenshine, R.J. 1987. Characteristics of an early hominid scavenging niche. *Current Anthropology* 28: 383-407.

Blumenschine, R.J., F.T. Masao 1991. Living sites at Olduvai Gorge, Tanzania? Preliminary landscape archaeology results in the basal Bed II lake margin zone. *Journal of Human Evolution* 21: 451-462.

Blumenshine, R.J., C.R. Peeters 1998. Archaeological predictions for hominid land use in the paleo-Olduvai Basin, Tanzania, during lowermost Bed II times. *Journal of Human Evolution* 34: 565-607.

Blumenschine, R.J., C.R. Peters, F.T. Masao, R.J. Clarke, A.L. Deino, R.L. Hay, C.C. Swisher, I.G. Stanistreet, G.M. Ashley, L.J. McHenry, N. van der Sikes, N.J.Merwe, J.C. Tactikos, A. Cushing, D.M. Deocampo, J.K. Njau, J.I. Ebert 2003. Late Pliocene Homo and hominid land use from western Olduvai Gorge, Tanzania. *Science* 299: 1217-1221.

Blumenshine, R.J., F.T. Masao, J.C. Tactikos, J.I. Ebert 2008. Effects of distance from stone source on landscape-scale variation in Oldowan artifact assemblages in the Paleo-Olduvai Basin, Tanzania. *Journal of Archaeological Science* 35: 76-86.

Blumenschine, R.J., F.T. Masao, I.G. Stanistreet 2009. Changes in hominin transport of stone for Oldowan tools across the eastern Olduvai Basin during lowermost Bed II times. In: K. Schick, N. Toth (eds.), *The Cutting Edge: New Approaches to the Archaeology of Human Origins*, pp. 1-15. Gosport (IN): Stone Age Institute Press.

Blumenshine, R.J., I.G. Stanistreet, F.T. Masao 2012. Olduvai Gorge and the Olduvai Landscape Paleoanthropology Project. *Journal of Human Evolution* 63: 247-250.

Boccaccio, G. 2005. *Les industries lithiques du Solutréen supérieur et du Salpêtrien ancien en Languedoc : ruptures et continuités des traditions techniques*. Unpublished Doctoral Dissertation, Université de Provence – Aix-Marseille I.

Bodin, E. 2011. *Analyse techno-fonctionnelle des industries à pièces bifaciales aux pléistocènes inférieur et moyen en Chine*. Unpublished Doctoral Dissertation, Université de Paris X-Nanterre.

Bodu, P. 1994. *Analyse typo-technologique du matériel lithique de quelques unités du site magdalénien de Pincevent (Seine-et-Marne). Applications spatiales, économiques et sociales*. Unpublished Doctoral Dissertation, Université de Paris I-Sorbonne.

Bodu, P., B. Valentin 1997. Groupes à Federmesser ou Aziliens dans le sud et l'ouest du Bassin parisien. Propositions pour un nouveau modèle d'évolution. *Bulletin de la Société préhistorique française* 94(3): 341-348.

Bodu, P., F. Bon, L. Brou (eds.) 2001. *Le Paléolithique supérieur au centre et au sud du Bassin parisien : « Des systèmes techniques aux comportements »*. Unpublished Rapport de projet collectif de recherche. Saint-Denis: Service régional de l'Archéologie d'Île-de-France.

Bodu, P., G. Debout, O. Bignon 2006. Variabilité des habitudes tardiglaciaires dans le Bassin parisien : l'organisation spatiale et sociale de l'Azilien ancien du Closeau. *Bulletin de la Société préhistorique française* 103(4): 711-728.

Boëda, E. 1982. Etude expérimentale de la technologie des pointes Levallois. In : D. Cahen (ed.), *Tailler ! Pour quoi faire : recent progress in microwear studies*, pp. 23-56. Tervuren: Studiae praehistorica belgica 2.

Boëda, E. 1986. *Approche technologique du concept Levallois et évaluation de son champ d'application: étude de trois gisements saaliens et weichséliens de la France septentrionale*. Doctoral Dissertation, Université de Paris X-Nanterre.

Boëda, E. 1988. Analyse technologique du débitage du niveau IIA. In: A. Tuffreau, J. Sommé (eds.), *Le Gisement Paléolithique Moyen de Biache-Saint-Vaast (Pas-de-Calais), vol I.*, pp. 185-214. Paris: Mémoires de la Société Préhistorique Française.

Boëda, E. 1990. De la surface au volume: analyse des conceptions des débitages Levallois et laminaire. In: C. Farizy (ed.), *Paléolithique moyen récent et Paléolithique supérieur ancien en Europe*, pp. 63-68. Aix-en-Provence: Mémoires du Musée de Préhistoire d'Ile-de-France 3.

Boëda, E. 1991. Approche de la variabilité des systèmes de production lithique des industries du paléolithique inférieur et moyen : Chronique d'une variabilité attendue. *Technique & Culture* 17-18: 37-79.

Boëda, E. 1993. Le débitage Discoïde et le débitage Levallois récurrent centripète. *Bulletin de la Société préhistorique française* 90(6): 392-404.

Boëda, E. 1994. *Le Concept Levallois : variabilité des méthodes*. Paris: CNRS Éditions.

Boëda, E. 1995a. Caractéristiques techniques des chaînes opératoires lithiques des niveaux micoquiens de Külna (Tchécoslovaquie). *Paléo* 1(1): 57-72.

Boëda, E. 1995b. Steinartefakt-Produktionssequenzen im Micoquien der Kulna-Höhle. *Quartär* 45/46: 75-98.

Boëda, E. 1997. *Technogenèse du système de production lithique au Paléolithique inférieur et moyen en Europe occidentale et au Proche-Orient*. Unpublished Habilitation, Université de Paris X-Nanterre.

Boëda, E. 2001. Determination des unités techno-fonctionelles de pièces bifaciales provenant de la couche acheuléenne C'3 Base du site de Barbas In: D. Cliquet (ed.), *Les industries à outil bifaciaux du Paléolithique moyen d'Europe occidentale*, pp. 51-75. Liège: ERAUL 98.

Boëda, E. 2005. Paléo-technologie ou anthropologie des Techniques ? *Arob@se* 1: 46-64.

Boëda, E. 2013. *Techno-logique & Technologie. Une Paléohistoire des objets lithiques tranchants*. Paris: @rchéo-éditions.

Boëda, E., J. Pelegrin 1983. Approche technologique du nucléus levallois à éclats. *Études Préhistoriques* 15: 41-48.

Boëda, E., J. Pelegrin 1985. *Les amas lithiques de la zone N 19 du gisement magdalénien de Marsangy : approche méthodologique par l'expérimentation*. Bourgogne: Édition Archéodrome.

Boëda, E., J.-M. Geneste, L. Meignen 1990. Identification de chaînes opératoires lithiques du Paléolithique ancien et moyen. *Paléo* 2(1): 43-80.

Boëda, E., X. Hou 2004. Relationship between East and West Asia in Paleolithic Age. *Quaternary Sciences* 3: 255-264.

Boëda, E., Y.M. Hou 2011. Analyse des artefacts lithiques du site de Longgupo. *L'anthropologie* 115: 78-175.

Boëda, E., C. Criggo, S. Soriano 2001. Différents modes d'occupation du site d'Umm el Tlel au cours du Paléolithique moyen (El Kowm, Syrie centrale). *Paléorient* 27(2): 13-28.

Boëda, E., S. Soriano, S. Noël-Soriano 2004. Fonction et fonctionnement d'un site à la fin du Pléistocène moyen. Le niveau acheuléen C'3 base de Barbas I (Creysse, Dordogne). In: P. Bodu, C. Constantin (eds.), *Approches fonctionnelles en préhistoire*, pp. 307-323. Paris: Société préhistorique française.

Boëda, E., Y.M. Hou, H. Forestier, J. Sarel, H.M. Wang 2013a. Levallois and non-Levallois blade production at Shuidonggou in Ningxia, North China. *Quaternary International* 295: 191-203.

Boëda, E., A. Lourdeau, C. Lahaye, G. Daltrini Felice, S. Viana, I. Clemente-Conte, M. Pino, M. Fontugne, S. Hoeltz, N. Guidon, Niède; A.-M. Pessis, A. Da Costa, M. Pagli 2013b. The Late-Pleistocene Industries of Piauí, Brazil: New Data. *Paleoamerican Odysse* 2013: 445-465.

Boëda, E., I. Clemente-Conte, M. Fontugne, C. Lahaye, M. Pino, G. Daltrini Felice, N. Guidon, S. Hoeltz, A. Lourdeau, M. Pagli, A.-M. Pessis, S. Viana, A. Da Costa, E. Douville 2014. A new late Pleistocene archaeological sequence in South America: the Vale da Pedra Furada (Piauí, Brazil). *Antiquity* 88: 927-955.

Boëda, E., S. Bonilauri, E. Kaltnecker, H. Valladas, H. Al-Sakhel 2015. Un débitage lamellaire au Proche-Orient vers 40 000 ans cal BP. Le site d'Umm el Tlel, Syrie centrale. *L'anthropologie* 119: 141-169.

Bohannan, P. 1955. Some principles of exchange and investment among the Tiv. *American Anthropologist* 57(1): 60-70.

Bohannan, P. 1959. The impact of money on an African subsistence economy. *The Journal of Economic History* 19(4): 491-503.

Boissinot, P. 2011. Comment sommes-nous déficients ? Une manière d'envisager la spécificité de l'archéologie. *Le Genre humain* 1(50): 265-307.

Boissinot, P. 2015. *Qu'est-ce qu'un fait archéologique ?*. Paris: EHESS.

Boivin, N.L. 2010. The Sealinks Project: Exploring the early Indian Ocean. *British Institute in Eastern Africa News* 10: 1-2.

Boivin, N.L., R. Crassard, M.D. Petraglia (eds.) 2017. *Human Dispersal and Species Movement*. Cambridge: Cambridge University Press.

Bolten, J. 1985. Die Hermeneutische Spirale. Überlegungen zu einer integrativen Literaturtheorie. *Poetica* 17(3/4): 355-371.

Bon, F. 2000. *La question de l'unité technique et économique de l'Aurignacien : réflexions sur la variabilité des industries lithiques à partir de l'étude comparée de trois sites des Pyrénées françaises (La Tuto de Camalhot, Regismont-le-Haut et Brassempouy)*. Doctoral Dissertation, Université de Paris I-Sorbonne.

Bon, F. 2002. *L'Aurignacien entre Mer et Océan. Réflexion sur l'unité des phases anciennes de l'Aurignacien dans le sud de la France*. Paris: Société préhistorique française.

Bon, F. 2005. Little big tool: Enquête autour du succès de la lamelle. In: F. Le Brun-Ricalens, in collaboration with J.-G. Bordes and F. Bon (eds.). *Productions lamellaires attribuées à l'Aurignacien : chaînes opératoires et perspectives technoculturelles*, pp. 479-484. ArchéLogiques 1. Luxembourg: Publications du Musée National d'Histoire et d'Art Luxembourg.

Bon, F. 2006. Les termes de Aurignacien. In: F. Bon, J.M. Maíllo Fernandez, D. Ortega i Cobos (eds.), *Autour des concepts de Protoaurignacien, d'Aurignacien archaïque, initial et ancien. Unité et variabilité des* *comportements techniques des premiers groupes d'hommes modernes dans le sud de la France et le nord de l'Espagne*, pp. 39-65. Madrid: UNED.

Bon, F. 2009. *Préhistoire. La fabrique de l'homme*. Paris: Éditions du Seuil.

Bon, F. 2010. Les Aurignaciens et l'émergence du Paléolithique supérieur. In: Jean Clottes (ed.), *La France préhistorique. Un essai d'histoire*, pp. 116-141. Paris: Gallimard.

Bon, F. 2015. À la croisée des chemins (crossroad traffic). In: R. White, R. Bourillon, F. Bon (eds.), Aurignacian Genius : art, technologie et société des premiers hommes modernes en Europe. *P@lethnologie* 7: 8-18.

Bon, F., J.M. Maíllo Fernandez, D. Ortega i Cobos (eds.) 2006. *Autour des concepts de Protoaurignacien, d'Aurignacien archaïque, initial et ancien. Unité et variabilité des comportements techniques des premiers groupes d'hommes modernes dans le sud de la France et le nord de l'Espagne*. Madrid: UNED.

Bondy, J.A., U.S.R. Murty 1976. *Graph Theory with Applications*. New York: Elsevier Science Ltd (North-Holland).

Bonilauri, S. 2010. *Les outils du Paléolithique moyen : une mémoire technique oubliée ? Approche techno-fonctionnelle appliquée à un assemblage lithique de conception Levallois provenant du site d'Umm el Tlel (Syrie centrale)*. Unpublished Doctoral Dissertation, Université de Paris X-Nanterre.

BonJour, L. 1976. The Coherence Theory of Empirical Knowledge. *Philosophical Studies* 30: 281-312.

BonJour, L. 1985. *The Structure of Empirical Knowledge*. Cambridge (MA): Harvard University Press.

Bonnemaison J. 2000. *La géographie culturelle*. Paris: Éditions du CTHS.

Bonner, J.T. 1988. *The Evolution of Complexity by Means of Natural Selection*. Princeton (NJ): Princeton University Press.

Bordes, F. 1950. Principes d'une méthode d'étude des techniques de débitage et de la typologie du Paléolithique ancien et moyen. *Bulletin de la Société préhistorique française* 54(1-2): 19-34.

Bordes, F. 1961a. *Typologie du Paléolithique ancien et moyen, tome 1*. Bordeaux: Delmas.

Bordes, F. 1961b. *Typologie du Paléolithique ancien et moyen, tome 2 (planches)*. Bordeaux: Delmas.

Bordes, F. 1961c. Mousterian cultures in France. *Science* 134: 803-810.

Bordes, F. 1963. À propos de la théorie de M. Laplace sur le synthétotype aurignaco-gravettien: quelques questions préalables. *L'Anthropologie* 67(3-4): 347-360.

Bordes, F. 1968. *The Old Stone Age*. New York: McGraw-Hill.

Bordes, F. 1972. *A Tale of Two Caves*. London: Harper and Row.

Bordes, F., D. de Sonneville-Bordes 1970. The significance of variability in Paleolithic assemblages. *World Archaeology* 2: 61-73.

Bordes, F., J.-P. Rigaud and D. de Sonneville-Bordes 1972. Des buts, Problèmes et limites de l'archéologie paléolithique. *Quaternaria* XVI: 15-34.

Bordes, J.-G., J. Tixier 2002. Sur l'unité de l'Aurignacien ancien dans le Sud-Ouest de la France : la production des lames et des lamelles. *Espacio Tiempo y Forma, Serie I, Prehistoria y Arqueología* 1(15): 175-194.

Bordes, J.-G., N. Teyssandier 2011. The Upper Paleolithic nature of the Châtelperronian in South-Western France: Archeostratigraphic and lithic evidence. *Quaternary International* 246(1): 382-388.

Borgerhoff Mulder, M. 2005. Human Behavioural Ecology. *The Encyclopedia of Life Sciences*. New York: Wiley.

Bourdieu, P. 1972. *Esquisse d'une théorie de la pratique*. Paris/Geneva: Droz.

Bourdieu, P. 1979. *La Distinction. Critique sociale du jugement*. Paris: Les Éditions de Minuit.

Bourguignon, L. 1996. La conception de débitage Quina. *Quaternaria Nova* 6: 149-166.

Bourguignon, L. 1997. *Le Moustérien de type Quina: nouvelle définition d'une entité technique*, 2 volumes. Unpublished Doctoral Dissertation, Université de Paris X–Nanterre.

Bourguignon, L., A. Turq 2003. Une chaîne opératoire de débitage discoïde sur éclat du Moustérien à denticulés aquitain : les exemples de Champ de Bossuet et de Combe-Grenal. In: M. Peresani (ed.), *Discoid lithic technology - Advances and implications*, pp. 131-152. BAR International Series 1120. Oxford : Archaeopress.

Bourguignon, L., J.-P. Faivre, A. Turq 2004. Ramification des chaînes opératoires : une spécificité de Moustérien ? *Paléo* 16: 37-48.

Bourguignon, L., A. Delagnes, L. Meignen 2006. Systèmes de production lithique, gestion des outillages et territoires au Paléolithique moyen: où se trouve la complexité ? In: L. Astruc, F. Bon, V. Léa, P.-Y. Milcent, S. Philibert (eds.), *Normes techniques et pratiques sociales. De la simplicité des outillages pré- et protohistoriques*, pp. 75-86. Antibes: APDCA.

Bousman, C.B. 1993. Hunter-gatherer adaptations, economic risk, and tool design. *Lithic Technology* 18: 59-86.

Bousman, C.B. 2005. Coping with risk: Later stone age technological strategies at Blydefontein Rock Shelter, South Africa. *Journal of Anthropological Archaeology* 24(3): 193-226.

Bovier, A. 2009. Metastability. In: M. Biskup, A. Bovier, F. den Hollander, D. Ioffe, F. Martinelli, K. Netocný, F. Toninelli (eds.), *Methods of Contemporary Mathematical Statistical Physics*, pp. 178-221. Berlin: Springer.

Bowler, P.J. 1978. Hugo de Vries and Thomas Hunt Morgan: The mutation theory and the spirit of Darwinism. *Annals of Science* 35(1): 55-73.

Boyd, R., P.J. Richerson 1985. *Culture and the Evolutionary Process*. Chicago: University of Chicago Press.

Boylan, T.A., P. O'Gorman 2013. Duham-Quine Thesis and the Social Sciences. In: B. Kaldis (ed.), *Encyclopedia of Philosophy and the Social Sciences*, pp. 213-215. Los Angeles: Sage Publications.

Bradley, F. 1914. *Essays on Truth and Reality*. Oxford: Clarendon Press.

Boyle, K., C. Gamble, O. Bar-Yosef (eds.) 2010. *The Upper Palaeolithic Revolution in global perspective. Papers in honour of Sir Paul Mellars*. Cambridge: McDonald Institute for Archaeological Research.

Bradley, R. 2015. Repeating the unrepeatable experiment. In: R. Chapman, A. Wylie (eds.), *Material Evidence. Learning from archaeological practice*, pp. 23-41. London: Routledge.

Brain, C. K. 1967. Bone Weathering and the Problem of Bone Pseudo-Tools. *South African Journal of Science* 63: 97-99.

Brain, C.K. 1981. *The Hunters or the Hunted? An Introduction to African Cave Taphonomy*. Chicago: Chicago University Press.

Brantingham, P.J. 2003. A neutral model of stone raw material procurement. *American Antiquity* 68: 487-509.

Brantingham, P.J. 2010. The Mathematics of Chaînes Opératoires. In: S.J. Lycett, P.R. Chauhan (eds.), *New Perspectives on Old Stones. Analytical Approaches to Paleolithic Technologies*, pp. 183-206. New York: Springer.

Brantingham, P.J., S.L. Kuhn 2004. Constraints on Levallois Core Technology: A Mathematical Model. *Journal of Archaeological Science* 28: 747-761.

Braudel, F. 1949. *La Méditerranée et le monde méditeranéen à l'epoque de Philippe II*. Habilitation, Université de Paris.

Braun, D.R. 2006. *The Ecology of Oldowan Technology: Perspectives from Koobi Fora and Kanjera South*. Unpublished Doctoral Dissertation, Rutgers University.

Braun, D.R. 2013. The Behavior of Plio-Pleistocene Hominins: Archaeological Perspectives. In: M. Sponheimer, J.A. Lee-Thorp, K.E. Reed, P.S. Ungar (eds.), *Early Hominin Paleoecology*, pp. 325-351. Boulder: University Press of Colorado.

Braun, D.R., J.W.K. Harris 2001. Technological Developments in the Oldowan of Koobi Fora: Innovative Techniques of Artifact Analysis. In: J. Martínez Moreno, R.M. Torcal, I. de la Torre Sainz (eds.), *Oldowan: Rather more than smashing stones*, pp. 117-144. Barcelona: Treballs d'Archeologia 9.

Braun, D.R., M.J. Rogers, J.W.K. Harris, S.J. Walker 2008a. Landscape-scale variation in hominin tool use: Evidence from the Developed Oldowan. *Journal of Human Evolution* 55: 1053-1063.

Braun, D.R. B.L. Pobiner, J.C. Thompson 2008b. An experimental investigation of cut mark production and stone tool attrition. *Journal of Archaeological Science* 35: 1216-1233.

Braun, D.R., T. Plummer, P. Ditchfield, L. Bishop, J. Ferraro 2009. Oldowan technology and raw material variability at Kanjera South. In: E. Hovers, D.R. Braun (eds.), *Interdisciplinary approaches to the Oldowan*, pp. 99-110. New York: Springer.

Bredekamp, H., B. Schneider, V. Dünkel (eds.) 2008. *Das Technische Bild. Kompendium zu einer Stilgeschichte wissenschaftlicher Bilder*. Berlin: Akademie Verlag.

Brenet, M. 2011. *Variabilité et signification des productions lithiques au Paléolithique moyen ancien. L'exemple de trois gisements de plein-air du Bergeracois (Dordogne, France)*. Unpublished Doctoral Dissertation, Université de Bordeaux I.

Brenet, M., M. Folgado 2009. Relations techno-économiques entre débitage et façonnage sur les gisements du Paléolithique moyen ancien de Cantalouette 1 et Combe Brune 3 (Creysse). *Rivista di Scienze Preistoriche* LIX: 49-62.

Brenet, M., L. Bourguignon, D. Cologne, M. Folgado, M. Jarry, L.-A. Lelouvier, V. Mourre, A. Turq 2014. Les techno-complexes au début du Paléolithique moyen en Aquitaine septentrionale : complexité, complémentarité des productions de débitage et de façonnage et implications comportementales. In: In: J. Jaubert, N. Fourment, P. Depaepe (eds.), *Transitions, ruptures et continuité en Préhistoire : Volume 2, Paléolithique et Mésolithique*, pp. 81-101. Paris: Société préhistorique française.

Brennan, A. 2017. Necessary and Sufficient Conditions. In: E.N. Zalta (eds.), *The Stanford Encyclopedia of Philosophy*: URL = https://plato.stanford.edu/archives/sum2017/entries/necessary-sufficient/ [last accessed 15.07.2018].

Brent, K. 1974. *Identifying World Views Projected by Science Teaching Materials: A Case Study Using Pepper's "World Hypotheses" to Analyse a Biology Textbook*. Unpublished Doctoral Dissertation, University of Toronto.

Brézillon, M. 1968. *La dénomination des objects de pierre taillée : matériaux pour un vocabulaire des préhistoriens de langue française*. Paris: Éditions du CNRS.

Bright, J., A.Ugan, L. Hunsacker 2002. The effects of handling time on subsistence technology. *World Archaeology* 34: 164-181.

Bril, B. 1984. Description du geste technique : Quelles méthodes ? *Techniques & Culture* 3: 81-96.

Brooks, A.S., J.E. Yellen, L. Nevell, G. Hartman 2006. Projectile Technologies of the African MSA: Implications for Modern Human Origins. In: E. Hovers, S.L. Kuhn (eds.), *Transition Before the Transition: Evolution and Stability in the Middle Paleolithic and Middle Stone Age*, pp. 233-255. New York: Springer.

Buchanan, B., M.J. O'Brien, M. Collard 2014. Continent-wide or region-specific? A geometric morphometrics-based assessment of variation in Clovis point shape. *Archaeological and Anthropological Sciences* 6(2): 145-162.

Bueno, O. 2012. Styles of reasoning: A pluralist view. *Studies in History and Philosophy of Science* 43: 657-665.

Bueno, O. 2016. Visual Reasoning in Science and Mathematics. In: L. Magnani, C. Casadio (eds.), *Model-Based Reasoning in Science and Technology*, pp. 3-19. New York: Springer.

Bunge, M.A. 1981. A critique of dialectics. In: M.A: Bunge, *Scientific materialism*, pp. 41-63. Dordrecht: Kluwer Academic Publishers.

Bunge, M.A. 2004. How does it work? The search for explanatory mechanisms. *Philosophy of the Social Sciences* 34: 182–210.

Bunge, M.A. 2012. *Evaluating philosophies*. New York: Springer.

Bunge, M.A. 2013. Mechanism and Mechanismic Explanation. In: B. Kaldis (ed.), *Encyclopedia of Philosophy and the Social Sciences*, pp. 590-591. Los Angeles: Sage Publications.

Bunn, H.T. 1982. *Meat-eating and Human Evolution: Studies on the Diet and Subsistence Patterns of Plio-Pleistocene Hominids in East Africa*. Unpublished Doctoral Dissertation, University of California, Berkeley.

Bunn, H.T. 2007. Meat made us human. In: P.S. Ungar (ed.), *Evolution of the Human Diet: The Known, the Unknown, and the Unknowable*, pp. 191-211. Oxford: Oxford University Press.

Bunn, H.T., E.M. Kroll 1986. Systematic Butchery by Plio/Pleistocene Hominids at Olduvai Gorge, Tanzania. *Current Anthropology* 27: 431-452.

Bunn, H.T., J.W.K. Harris, Z. Kaufulu, E. Kroll, K. Schick, N. Toth, A.K. Behrensmeyer 1980. FxJj 50: An early Pleistocene site in northern Kenya. *World Archaeology* 12 : 109-136.

Butzer, K.W. 1964. *Environment and Archaeology: An Introduction to Pleistocene Geography*. Chicago: University of Chicago Press

[Butzer, K.W. 1971. *Environment and Archaeology: An Ecological Approach to Prehistory*. Second and substantially extended edition. Chicago: Aldine.]

Butzer, K.W. 1977. Environment, Culture, and Human Evolution: Hominids first evolved in mosaic environments, but stone toolmaking accelerated the emergence of Homo, and both culture and environment subsequently served as catalysts for evolution. *American Scientist* 65(5): 572-584.

Butzer, K.W. 1982. *Archaeology as Human Ecology: Method and Theory for a Contextual Approach*. Cambridge: Cambridge University Press.

Butzer, K.W. 1986. Paleolithic settlement and adaptation in Cantabrian Spain. *Advances in World Archaeology* 5: 201-252.

Butzer, K.W., G. Isaac (eds.) 1975. *After the Australopithecines: Stratigraphy, Ecology and Culture Change in the Middle Pleistocene*. The Hague: de Gruyter.

Butzer, K.W., R.G. Klein 2007. Obituary: F. Clark Howell (1925-2007). *Journal of Archaeological Science* 34: 1552-1553.

Byrd, B.F. 2013. Research strategy and analytical approach to chipped stone assemblages from Azraq Basin. In: N.A. Garrard, B.F. Byrd, *Beyond the Fertile Crescent. Late Palaeolithic and Neolithic communities of the Jordanian Steppe*, pp. 138-147. Oxford/Oakville: Oxbow Books.

Cahen, D., C. Karlin, L.H. Keeley, F. Van Noten 1980. Méthodes d'analyse technique, spatiale et fonctionnelle d'ensembles lithiques. *Helinium* 20: 209-259.

Cameron, D. 1993. Uniformitarianism And Prehistoric Archaeology. *Australian Archaeology* 36(1): 42-49.

Canales, J. 2015. *The Physicist & the Philosopher: Einstein, Bergson, and the Debate that Changed Our Understanding of Time*. Princeton/Oxford: Princeton University Press.

Canguilhem, J. 1969. *La connaissance de la vie*. Paris: Vrin.

Canguilhem, J. 1977. *Idéologie et rationalité dans l'histoire des sciences de la vie*. Paris: Librairie philosophique J. Vrin.

Carmignani, L. 2017. Between the flake and the blade: Associated systems of production at Riparo Tagliente (Veneto, northern Italy). *Journal of Lithic Studies* 4(1): 1-37.

Carmignani, L., M.-H. Moncel, P. Fernandes, L. Wilson 2017. Technological variability during the Early Middle Palaeolithic in Western Europe. Reduction systems and predetermined products at the Bau de l'Aubesier and Payre (South-East France). *PLoS ONE* 12(6): e0178550.

Carnap, R. 1967. *The Logical Structure of the World: Pseudoproblems in Philosophy*. Translated by Rolf A. George. Berkeley/Los Angeles: University of California Press.

Carr, P.J., A.P. Bradbury 2001. Flake Debris Analysis, Levels of Production, and the Organization of Technology. In: W. Andrefski Jr. (ed.), *Lithic Debitage: Context, Form, Meaning*, pp. 126-146. Salt Lake City: The University of Utah Press.

Carr, P.J., A.P. Bradbury 2011. Learning from lithics: A perspective on the foundation and future of the organization of technology. *PaleoAnthropology* 2011: 305-319.

Carrier, M. 2006. *Wissenschaftstheorie. Zur Einführung*. Hamburg: Junius.

Cartwright, N. 1999. *The Dappled World: A Study of the Boundaries of Science*. Cambridge: Cambridge University Press.

Cartwright, N. 2004. Causal Laws and Effective Strategies. *Noûs* 13(4): 419-437.

Cashdan, E. (ed.) 1990. *Risk and Uncertainty in Tribal and Peasant Economies*. Boulder (CO): Westview.

Cat, J. 2017. The Unity of Science. In: E.N. Zalta (ed.), *The Stanford Encyclopedia of Philosophy*: URL = https://plato.stanford.edu/archives/fall2017/entries/scientific-unity/ [last accessed 14.07.2018].

Chakravartty, A. 2005. Causal Realism: Events and Processes. *Erkenntnis* 63: 7-31.

Chalmers, D.J. 2006. Strong and Weak Emergence. In: P. Clayton, P. Davies (ed.), *The Re-Emergence of Emergence*, pp. 244-254. Oxford: Oxford University Press.

Chang, H. 2012. *Is Water H_2O? Evidence, Realism and Pluralism*. Dordrecht: Springer.

Chase, J., J. Reynolds 2010. *Analytic Versus Continental: Arguments on the Methods and Value of Philosophy*. London: Routledge.

Chase, P.G. 2008. Form, Function and Mental Templates in Paleolithic Lithic Analysis. Paper presented at the symposium *From the Pecos to the Paleolithic: Papers in Honor of Arthur J. Jelinek*, Meeting of the Society for American Anthropology, Vancouver, 28 March 2008.

Chase, P.G. 2016. Form, Function, and Mental Templates in Paleolithic Archaeology. In: A.P. Sullivan III, D.I. Olszewski (eds.), *Archaeological Variability and Interpretation in Global Perspective*, pp. 291-306. Boulder: University Press of Colorado.

Chase, P.G., A. Debénath, H.L. Dibble, S.P. McPherron 2009. *The cave of Fontéchevade: recent excavations and their Paleoanthropological implications*. Cambridge: Cambridge University Press.

Chazan, M. 1997. Lead Review. Redefining Levallois. *Journal of Human Evolution* 33: 719-735.

Chazan, M. 2014. Lithic Technology, Palaeolithic. In: C. Smith (ed.), *Encyclopedia of Global Archaeology*, pp. 4519-4525. New York: Springer.

Chazan, M. 2016. Technological radiation and the process of technological change at the end of the Levantine Lower Paleolithic. *Quaternary International* 411: 59-66.

Chehmana, L. 2009. The conception of "Bertonne" and "Orville" Bladelet Production (Upper Paleolithic, France). *Human Evolution* 24(1): 71-79.

Chen, J. 2016. *The Unity of Science and Economics. A New Foundation of Economic Theory*. New York: Springer.

Chevrier, B. 2012. *Les assemblages à pièces bifaciales au Pléistocène inférieur et moyen ancien en Afrique de l'Est et au Proche-Orient : nouvelle approche du phénomène bifacial appliquée aux problématiques de migrations, de diffusion et d'évolution locale*. Unpublished Doctoral Dissertation, Université de Paris X-Nanterre.

Chevrier, B., É. Huysecom, S. Soriano, M. Rasse, L. Lespez, B. Lebrun, C. Tribolo 2017. Between continuity and discontinuity: An overview of the West African Paleolithic over the last 200,000 years. *Quaternary International* 466: 3-22.

Chibnik, M. 2011. *Anthropology, Economics, and Choice*. Austin (TX): University of Texas Press.

Chivallon, C. 2003. « Une » vision de la géographie sociale et culturelle. *Annales de Géographie* 634: 646-657.

Chorley, R., P. Haggett (eds.) 1967. *Models in Geography: The second Madingley lectures*. London: Methuen.

Christensen, M. 1999. *Technologie de l'ivoire au Paléolithique supérieur. Characterisation physico-chimique du matériau et analyse fonctionnelle de outils de transformation*. Oxford: Archaeopress.

Chung, C. 2003. On the origin of the typological/population distinction in Ernst Mayr's changing views of species, 1942-1959. *Studies in History and Philosophy of Biological and Biomedical Sciences* 34: 277-296.

Churchill, S.E. 2014. *Thin on the Ground: Neandertal Biology, Archeology, and Ecology*. Oxford: Wiley-Blackwell.

Cicero, D.R. 2017. *Lithic Technology and Mobility in Late Pleistocene Southeast Asia: A Whole Assemblage Approach to Assessing Technological Behavior in Modern and Archaic Human Populations*. Unpublished Doctoral Dissertation, University of Colorado.

Clark, G.A. 1984. The Negev model for paleoclimate change and human adaptation in the Levant. *Annual of the Department of Antiquities of Jordan* 26: 225-248.

Clark, G.A. 1987. Paradigms and paradoxes in contemporary archaeology. In: M. Aldenderfer (ed.), *Quantitative Research in Archaeology: Progress and Prospects*, pp. 30-60. Beverly Hills: Sage Publications.

Clark, G.A. 1991a. Preface. In: G.A. Clark (ed.), *Perspectives on the Past*, pp. xvii-xix. Philadelphia: University of Pennsylvania Press.

Clark, G.A. 1991b. A paradigm is like an onion: reflections on my biases. In: G.A. Clark (ed.), *Perspectives on the Past*, pp. 79-108. Philadelphia: University of Pennsylvania Press.

Clark, G.A. 1991c. Epilogue: Paradigms, Realism, Adaptation, and Evolution. In: G.A. Clark (ed.), *Perspectives on the Past*, pp. 411-439. Philadelphia: University of Pennsylvania Press.

Clark, G.A. 1993. Paradigms in Science and Archaeology. *Journal of Archaeological Research* 1: 203-234.

Clark, G.A. 1994. Ragging the Radical Critique: Archaeology as Practically Anything Other than Science. In: J.L. Lantana, L.A. Borrero (eds.), *Arquelogía de Cazadores-Recolectores. Límites, Casos y Aperturas*, pp. 17-22. Buenos Aires: Programa de Estudios Prehistóricos.

Clark, G.A. 2001. Observations on the epistemology of human origins research. In: R. Corbey, W. Roebroeks (eds.), *Studying Human Origins. Disciplinary History and Epistemology*, pp. 139-146. Amsterdam: Amsterdam University Press.

Clark, G.A. 2002. Observations on paradigmatic bias in French and American Paleolithic Archaeology. In: L.G. Straus (ed.), *The Role of American Archaeologists in the Study of the European Upper Paleolithic*, pp. 19-26. BAR International Series 1048. Oxford: Archaeopress.

Clark, G.A. 2003. American Archaeology's Uncertain Future. *Archeological Papers of the American Anthropological Association* 13(1): 51-67.

Clark, G.A. 2006. Research Traditions in Paleoanthropology: An Archaeological Perspective. In: J. Hantman, R. Most (eds.), *Managing Archaeological Data: Essays in Honor of Sylvia W. Gaines*, pp. 3-15. Arizona: Arizona University Press.

Clark, G.A. 2009. Accidents of History: Conceptual Frameworks in Palaeoarchaeology. In: M. Camps, P. Chauhan (eds.), *Sourcebook of Paleolithic Transitions*, pp. 19-41. New York: Springer.

Clark, G.A., C.R. Stafford 1982. Quantification in American Archaeology: A Historical Perspective. *World Archaeology* 14(1): 98-119.

Clark, G.A., J.M. Lindly 1991. On Paradigmatic Biases and Paleolithic Research Traditions. *Current Anthropology* 32(5): 577-587.

Clark, G.A., C.M. Willermet (eds.) 1997. *Conceptual Issues in Modern Human Origins Research*. New York: de Gruyter.

Clark, G.A., C.M. Barton 2017. Lithics, landscapes & la Longue-duréé – Curation & expediency as expressions of forager mobility. Quaternary International 450: 137-149.

Clark, J.D., F.C. Howell (eds.) 1966. Recent Studies in Palaeoanthropology. *American Anthropologist* 68(2) [Special Issue].

Clark, J.D. 1986. Glynn Llywelyn Isaac, 1937-1985: a personal appreciation and assessment. *The African Archaeological Review* 4: 7-19.

Clark, J.D. 2001. Variability in primary and secondary technologies of the Later Acheulean in Africa. In: S. Milliken, J. Cook (eds.), *A Very Remote Period Indeed. Papers on the Palaeolithic Presented to Derek Roe*, pp. 1-18. Oxford: Oxbow Books.

Clark, J.G.D. 1952. *Prehistoric Europe: The Economic Basis*. London: Methuen.

Clark, J.G.D. 1989. *Economic Prehistory: Papers on Archaeology*. Cambridge: Cambridge University Press.

Clark, J.R. 1979. Measuring the flow of goods with archaeological data. *Economic Geography* 55: 1-17.

Clark, M. 1963. Knowledge and Grounds: A Comment on Mr. Gettier's Paper. *Analysis* 24(2): 46-48.

Clarke, D.L. 1968. *Analytical Archaeology*. London: Methuen & Co Ltd.

Clarke, D.L. (ed.) 1972a. *Models in Archaeology*. London: Methuen.

Clarke, D.L. 1972b. Models and paradigms in contemporary archaeology. In: D.L. Clarke (ed.), *Models in Archaeology*, pp. 1-60. London: Methuen

Clarke, D.L. (ed.) 1977. *Spatial Archaeology*. Boston: Academic Press.

Claud, E. 2008. *Le statut fonctionnel des bifaces au Paléolithique moyen récent dans le Sud-Ouest de la France. Etude tracéologique intégrée des outillages des sites de La Graulet, La Conne de Bergerac, Combe Brune 2, Fonseigner et Chez-Pinaud/Jonzac*. Unpublished Doctoral Dissertation, Université Bordeaux 1.

Claval, P. 2001. Champs et perspectives de la géographie culturelle. *Géographie & Cultures* 40: 5-28.

Claval, P. 2003. *Géographie culturelle*. Paris: Armand Colin.

Cleuziou, S., A. Coudart, J.-P. Demoule, A. Schnapp 1991. The Use of theory in French archaeology. In: I. Hodder (ed.), *Archaeological Therory in Europe*, pp. 91-128. London: Routledge.

Clinger, J. 2005. *Our Elders. Six Bay Area Life Stories*. Bloomington: Xlibris.

Close, A. 1991a. On the Validity of Middle Paleolithic Tool Types: A Test Case from the Eastern. *Journal of Field Archaeology* 18(2): 256-264.

Close, A. 1991b. Reply to Dibble. *Journal of Field Archaeology* 18(2): 267-269.

Cochet, H., R.W. Byrne 2015. Complexity in animal behaviour: towards common ground. *Acta ethologica* 18: 237-241.

Coinman, N., D.O. Henry 1995. The Upper Paleolithic Sites. In: D.O. Henry (ed.), *Prehistoric Cultural Ecology and Evolution Insights from Southern Jordan*, pp. 133-214. New York: Plenum Press.

Cole, J. 2015. Examining the Presence of Symmetry within Acheulean Handaxes: A Case Study in the British Palaeolithic. *Cambridge Archaeological Journal* 25(4): 713-732.

Cole, S.C. 2002. *Lithic raw material exploitation between 40,000 BP and 30,000 BP in the Perigord, France*. Unpublished Doctoral Dissertation, University of Washington, Seattle (WA).

Cole, S.C. 2009. Technological Efficiency as an Adaptive Behavior among Paleolithic Hunter-Gatherers: Evidence from La-Côte, Caminade Est, Le Flageolet I, France. In: B. Adams, B.S. Blades (eds.), *Lithic Materials and Paleolithic Societies*, pp. 127-143. Chichester: Wiley & Sons.

Coles, J., E. Higgs 1969. *The Archaeology of Early Man*. London: Faber.

Collard, I.F., R.A. Foley 2002. Latitudinal patterns and environmental determinants of recent human cultural diversity: do humans follow biogeographical rules?. *Evolutionary Ecology Research* 4(3): 371-383.

Collard, M., M. Kemery, S. Banks 2005. Causes of Toolkit Variation Among Hunter-Gatherers: A Test of Four Competing Hypotheses. *Canadian Journal of Archaeology* 29: 1-19.

Collins, J. 1999. The nature of archaeological evidence. In: G. Barker (ed.), *Companion Encyclopedia of Archaeology*. Volume 1-2, pp. 81-127. London: Routledge.

Conard, N.J. 2009. Commentary following O. Bar-Yosef, P. Van Peer, The Chaîne Opératoire Approach in Middle Paleolithic Archaeology. *Current Anthropology* 50(1): 103-131 [118-119].

Conard, N.J., M. Will 2015. Examining the Causes and Consequences of Short-Term Behavioral Change during the Middle Stone Age at Sibudu, South Africa. *PLoS ONE* 10(6): e0130001.

Conard, N.J., G. Porraz 2015. Revising Models for the Cultural Stratigraphic Sequence of the Middle Stone Age. *South African Archaeological Bulletin* 70(201): 127-130.

Conard, N.J., M. Soressi, J.E. Parkington, S. Wurz, R. Yates 2004. A Unified Lithic Taxonomy Based on Patterns of Core Reduction. *South African Archaeological Bulletin* 59(179): 13-17.

Conkey, M.W. 2014. André Leroi-Gourhan (1911-86): How Humans Make Their Worlds. In: B. Fagan (ed.), *The Great Archaeologists*, pp. 268-271. London: Thames & Hudson.

Coolidge, F.L., T. Wynn 2009. *The Rise of Homo Sapiens: The Evolution of Modern Thinking*. Malden (MA): Wiley-Blackwell.

Cooper, H. 1954. Progressive modification of a stone artifact. *Records of the South Australian Museum* 11: 91-103.

Copleston, F.S.J. 1994 [1974]. *A History of Philosophy, Volume IX. Modern Philosophy: From the French Revolution to Sartre, Camus and Lévi-Strauss*. New York: Image Books.

Corbey, R.H.A 2005. *The Metaphysics of Apes: Negotiating the Animal-Human Boundary*. Cambridge: Cambridge University Press.

Corbey, R.H.A., W. Roebroeks (eds.) 2001. *Studying Human Origins. Disciplinary History and Epistemology*. Amsterdam: Amsterdam University Press.

Corbey, R.H.A., A. Jagich, K. Vaesen, M. Collard 2016. The acheulean handaxe: More like a bird's song than a beatles' tune? *Evolutionary Anthropology* 25(1): 6-19.

Cornelius, B.A. 1962. Coherence Theory of Truth. In: D.D. Runes (ed.) *Dictionary of Philosophy*, p. 58. Totowa (NJ): Littlefield, Adams, and Company.

Corning, P.A. 2005. *Holistic Darwinism. Synergy, Cybernetics, and the Bioeconomics of Evolution*. Chicago/London: The University of Chicago Press.

Corruccini, R.S., R.L. Ciochon (eds.) 1994. *Integrative Paths to the Past: Paleoanthropological Advances in Honor of F. Clark Howell*. Englewood Cliffs (NJ): Prentice-Hall.

Cosmides, L., J. Tooby 1987. From evolution to behavior: evolutionary psychology as the missing link. In: J. Dupré (ed.), *The Latest on the Best: Essays on Evolution and Optimality*, pp. 277-306. Cambridge (MA): MIT Press.

Cosmides, L., J. Tooby 2008. *Universal Minds. Explaining the new science of evolutionary psychology*. Yale: Weidenfeld & Nicolson/London and Yale University Press.

Coudart, A. 1999. Is post-processualism bound to happen everywhere? The French case. *Antiquity* 73(279): 161-167.

Coudenneau, A. 2013. *Éléments triangulaires et armes de chasse au Paléolithique moyen. Constats et réflexions à travers l'étude techno-morpho-fonctionnelle de quatre séries d'Europe occidentale*. Unpublished Doctoral Dissertation, Aix-Marseille Université.

Coudret, P., J.-P. Fagnard 1997. Les industries à Federmesser dans le Bassin de la Somme : chronologie et identité des groupes culturels. *Bulletin de la Société préhistorique française* 94(3): 349-359.

Coupland, N., J.M. Wiemann, H. Giles 1991. Talk as "problem" and communication as "miscommunication": an integrative analysis. In: N. Coupland, H. Giles, J.M. Wiemann (eds.), *"Miscommunication" and Problematic Talk*, pp. 1-17. Newbury Park: Sage Publications.

Courgeau, D. 2003. General Introduction. In: D. Courgeau (ed.), *Methodology and Epistemology of Multilevel Analysis. Approaches from Different Social Sciences*, pp. 1-23. Dordrecht: Springer.

Cox, J., E.M. Goldratt 1986. *The goal: a process of ongoing improvement*. Great Barrington (MA): North River Press.

Coye, N. 1997. *La Préhistoire en parole et en acte. Méthodes et enjeux de la pratique archéologique (1830-1950).* Paris: L'Harmattan.

Coye, N. 2005. Remous dans le creuset des temps : la Préhistoire à l'épreuve des traditions académiques (1850-1950). *Bulletin de la Société préhistorique française* 102(4): 701-707.

Coye, N. (ed.) 2006. *Sur les chemins de la préhistoire, l'abbé Breuil du Périgord à l'Afrique du Sud*. Paris: Somogy Éditions d'Art.

Coye, N. 2015. Une pensée en action : André Leroi-Gourhan et la naissance de la préhistoire moderne. In: P. Soulier (ed.), *André Leroi-Gourhan, « l'homme simplement »*, pp. 135-144. Paris: Éditions de Boccard.

Coye, N., A. Hurel 2013. L'archéologie préhistorique dans les pays de l'Europe du Sud : dimension européenne et dynamiques nationales. *Bulletin du musée d'Anthropologie préhistorique de Monaco* 53: 63-68.

Crassard, R. 2007. *Apport de la technologie lithique à la définition de la Préhistoire du Hadramawt, dans le contexte du Yémen et de l'Arabie du Sud*. Doctoral Dissertation, Université Paris I-Sorbonne.

Cresswell, R. 1976 (with G. Hanning). Note sur l'habitat traditionnel. Transferts de techniques et chaînes opératoires. *Etablissements humains et environnement socio-culturel* 1: 1-42.

Cresswell, R. 1983. Transferts de techniques et chaînes opératoires. *Techniques & Culture* 2: 144-159.

Cresswell, R. 1994. La nature cyclique des relations entre le technique et le social. Approche technologique de la chaîne opératoire. In : B. Latour, P. Lemonnier (eds.), *De la préhistoire aux missiles balistiques, l'intelligence des techniques*, pp. 275-289. Paris: La Découverte.

Cresswell, R. 2010. Techniques et culture: Les bases d'un programme de travail. *Techniques & Culture* 54-55: 20-45.

Cretin, C. 1996. Vers une nouvelle perception du Badegoulien des Jamblancs : Premiers éléments techno-économiques. *Paléo* 8: 243-268.

Cretin, C. 2000. *Tradition et variabilité dans le comportement technique : le cas du Badegoulien et du Magdalénien en Périgord*. Unpublished Doctoral Dissertation, Université de Paris I-Sorbonne.

Cruslock, E.M., L.A. Naylor, Y.L. Foote, J.O.H. Swantesson 2010. Geomorphologic equifinality: A comparison between shore platforms in Höga Kusten and Fårö, Sweden and the Vale of Glamorgan, South Wales, UK. *Geomorphology* 114(1): 78-88.

Csányi, V., G., Kampis 1985. Autogenesis: The Evolution of Replicative Systems. *Journal of Theoretical Biology* 114(2): 303-321.

Cucen, A.K. 2017. The Distinction between the Historical and the Systematic Approaches to Philosophy. *International Journal of Humanities and Management Sciences* 5(1): https://doi.org/10.15242/IJHMS.UH0417105.

Culley, E., G. Popescu, G.A. Clark 2013. An analysis of the compositional integrity of the Levantine Mousterian facies. *Quaternary International* 300: 213-233.

Currie, A. 2015. Philosophy of Science and the Curse of the Case Study. In: C. Daly (ed.), *The Palgrave Handbook of Philosophical Methods*, pp. 553-572. London: Palgrave Macmillan.

Currie, A., D. Turner 2016. Introduction: Scientific knowledge of the deep past. *Studies in History and Philosophy of Science* 55: 43-46.

Daley, M. 2000. *An Image of Enduring Plurality in Economic Theory: The Root Metaphor Theory of Stephen C. Pepper*. Unpublished Doctoral Dissertation, University of New Hampshire.

Dalton, G. 1961. Economic theory and primitive society. *American Anthropologist* 63(1): 1-25.

Dalton, G. 1969. Theoretical issues in economic anthropology. *Current Anthropology* 10(1): 63-102.

Daniel, G.E. 1981. *A Short History of Archaeology*. London: Thames and Hudson.

Darwin, C.R. 1859. *On the origin of species by means of natural selection, or the preservation of favoured races in the struggle for life*. London: John Murray.

Daston, L. 2008. On scientific observation. *Isis* 99: 97-110.

Daston, L. 2014. Beyond Representation. In: C. Coopmans, J. Vertesi, M.E. Lynch, S. Woolgar (eds.), *Representation in Scientific Practice Revisited*, pp. 319-322. Cambridge (MA)/London: The MIT Press.

Daston, L., P. Galison 1992. *The Image of Objectivity*. Representations 40: 81-128.

Dauvois, M. 1976. *Précis de dessin dynamique et structural des industries lithiques préhistoriques*. Paris: Fanlac.

David, M. 1994. *Correspondence and disquotation*. Oxford: Oxford University Press.

Davidson, D. 1970. Mental events. *Readings in Philosophy of Psychology* 1: 107-119.

Davidson, D. 1973. On The Very Idea of a Conceptual Scheme. *Proceedings and Addresses of the American Philosophical Association* 47: 5-20.

Davidson, I., W. Noble 1993. Tools and language in human evolution. In: K. Gibson, T. Ingold (eds.), *Tools, language, and cognition in human evolution*, pp. 363-388. Cambridge: Cambridge University Press.

Davies, S. 2001. *Musical Works and Performances: A Philosophical Exploration*. Oxford: Oxford University Press.

Davies, S. 2012. On Defining Music. *The Monist* 95: 535-555.

Davies, W. D. White, M., Lewis, C. Stringer 2015. Evaluating the transitional mosaic: frameworks of change from Neanderthals to Homo sapiens in eastern Europe. *Quaternary Science Reviews* 118: 211-242.

Davis, Z.J., J.J. Shea 1998. Quantifying Lithic Curation: An Experimental Test of Dibble and Pelcin's Original Flake-Tool Mass Predictor. *Journal of Archaeological Science* 25(7): 603-610.

Dawkins, R. 1982. *The Extended Phenotype. The Gene as the Unit of Selection*. Oxford: Oxford University Press.

Dawson, M.-C., S. Bernard-Guelle, M. Rué, P. Fernandes 2012. New data on the exploitation of flint outcrops during the Middle Palaeolithic: the Mousterian workshop of Chêne Vert at Dirac (Charente, France). *Paléo* 23: 55-84.

Deacon, J. 1982. *The Later Stone Age in the Southern Cape, South Africa*. Unpublished Doctoral Dissertation, University of Cape Town.

Deacon, T.W. 2011. *Incomplete Nature: How Mind Emerged from Matter*. New York: W.W. Norton & Company.

Deacon, T.W. 2016. Reconsidering Darwin's "Several Powers". *Biosemiotics* 9(1): 121-128.

de Beaune, S.A. 2000. *Pour une archéologie du geste*. Paris: CNRS Éditions.

de Beaune, S.A. 2008. *L'homme et l'outil. L'invention technique durant la préhistoire*. Paris: CRNS Éditions.

de Beaune, S.A. (eds.) 2010. *Ecrire le passé : la fabrique de la préhistoire et de l'histoire à travers les siècles*. Paris: CRNS Editions.

de Beaune, S.A. 2011. La genèse de la technologie comparée chez André Leroi-Gourhan. Introduction à son article « L'homme et la nature » paru dans L'Encyclopédie française en 1936 ». *Documents pour l'histoire des techniques* 20 [URL = http://dht.revues.org/1826].

de Beaune, S.A. 2012. Que nous dit la Préhistoire des conditions de l'invention ? In: I. Toulouse (ed.), *Technique et Création*, pp. 53-70. Paris: L'Harmattan.

de Beaune, S.A. 2016. *Qu'est-ce que la Préhistoire*. Paris: Gallimard.

Debenath, A., F. Delpech, H. Laville Henri, J.-P. Rigaud 1992. L'école de Bordeaux. In: *La Préhistoire en France. Musées, écoles de fouilles, associations…*, pp. 33-36. Paris: Editions du C.T.H.S.

Debout, G., M. Olive, O. Bignon, P. Bodu, L. Chehmana, B. Valentin 2012. The Magdalenian in the Paris Basin: New results. *Quaternary International* 272-273: 176-190.

Deforge Y., 1985. *Technologie et génétique de l'objet technique*. Paris: Maloine.

Delage, C. 2017. Once upon a time…the (hi)story of the concept of the *chaîne opératoire* in French prehistory. *World Archaeology* 49(2) : 158-173.

Delagnes, A. 1992. *L'organisation de la production lithique au Paléolithique moyen. Approche technologique à partir de l'étude des industries de La Chaise-de-Vouthon (Charente)*. Unpublished Doctoral Dissertation, Université de Paris X-Nanterre.

Delagnes, A. 1993. Un mode de production inédit au Paléolithique moyen dans l'industrie du niveau 6e du Pucheuil (Seine-Maritime). *Paléo* 5: 111-120.

Delagnes, A. 1995. Faible élaboration technique et complexité conceptuelle: deux notions complémentaires. *Cahier noir* 7: 101-110.

Delagnes, A. 2010. *Systèmes techniques, subsistance et mobilité au Paléolithique moyen : interactions et implications diachroniques*. Habilitation, Université de Bordeaux I.

Delagnes, A., H. Roche 2005. Late Pliocene hominid knapping skills: The case of Lokalalei 2C, West Turkana, Kenya. *Journal of Human Evolution* 48: 435-472.

Delagnes, A., L. Meignen 2006. Diversity of lithic production systems during the middle Palaeolithic in France. Are there any chronological trends? In: E. Hovers, S.L. Kuhn (eds.), *Transitions before the Transition. Interdsiciplinary Contributions to Archaeology*, pp. 87-107. New York: Springer.

Delagnes, A., W. Rendu 2011. Shifts in Neandertal mobility, technology and subsistence strategies in western France. *Journal of Archaeological Science* 38(8): 1771-1783.

Delagnes, A., C. Tribolo, P. Bertran, M. Brenet, R. Crassard, J. Jaubert, L. Khalidi, N. Mercie, S. Nomade, S. Peigné, L. Sitzia, J.-F. Tournepiche, M. Al-Halibi, A. Al-Mosabi, R. Macchiarelli 2012. Inland human settlement in southern Arabia 55,000 years ago. New evidence from the Wadi Surdud Middle Paleolithic site complex, western Yemen. *Journal of Human Evolution* 63: 452-474.

DeLanda, M. 2015. The New Materiality. *Architectural Design* 85(5): 16-21.

de la Torre, I., R. Mora 2009. Remarks on the Current Theoretical and Methodological Approaches to the Study of Early Technological Strategies in Eastern Africa. In: E. Hovers, D.R. Braun (eds.), *Interdisciplinary Approaches to the Oldowan*, pp. 15-24. Dordrecht: Springer.

Deleuze, G. 1966. *Le Bergsonisme*. Paris: PUF.

Deleuze, G. 1968. *Différence et repetition*. Paris: PUF.

Delley, G., M. Díaz-Andreu, F. Djindjian, V.M. Férnandez, A. Guidi, M.-A. Kaeser (eds.) 2017. *History of Archaeology: International Perspectives*. Oxford: Archaeopress.

Dell'Utri, M. 2017. "Metaphysics Without Ethics is Blind": The Legacy of Hilary Putnam. *Journal for General Philosophy of Science* 48(4): 501-515.

Demars, P.-Y. 2011. François Bordes versus Georges Laplace : deux visions de l'outillage lithique. In: F. Delpech, J. Jaubert (eds.), *François Bordes et la Préhistoire*, pp. 125-131. Paris: Éditions du CTHS.

Dennell, R. 1983. *European Economic Prehistory: A New Approach*. New York: Academic Press.

Dennell, R. 1990. Progressive gradualism, imperialism and academic fashion: Lower Palaeolithic archaeology in the 20th century. *Antiquity* 64: 549-558.

Dennell, R. 1999. Hunter-Gatherer Societies. In: G. Barker (ed.), *Companion Encyclopedia of Archaeology*. Volume 1-2, pp. 797-838. London: Routledge.

Dennell, R. 2013. Hominins, deserts, and the colonisation and settlement of continental Asia. *Quaternary International* 300: 13-21.

de Regt, H.W. 2009. The Epistemic Value of Understanding. *Philosophy of Science* 76: 585-597.

de Regt, H.W. 2014. Visualization as a Tool for Understanding. *Perspectives on Science* 22(3): 377-396.

de Regt, H.W., D. Dieks 2005. A Contextual Approach to Scientific Understanding. *Synthese* 144(1): 137-170.

Derrida, J. 1967. *De la Grammatologie*. Paris: Minuit.

Derrida, J. 1993. *Spectres de Marx*. Paris: Galilée.

Deschamps, M. 2014. *La diversité culturelle au paléolitique moyen récent : le vasconien et sa signification au sein des faciès moustériens*. Unpublished Doctoral Dissertation, Université Toulouse II - Le Mirail.

Deschamps, M. 2017. Late Middle Palaeolithic assemblages with flake cleavers in the western Pyrenees: The Vasconian reconsidered. *Quaternary International* 433(B): 33-49.

de Villiers, B. 2010. Husserl, Leroi-Gourhan et la préhistoire. Paris: Éditions Pétra.

de Weyer, L. 2016. *Systèmes techniques et variabilité fonctionnelle des industries anciennes en Afrique de l'Est et en Europe. Nouvelle approche des premières industries du Pléistocène inférieur*. Unpublished Doctoral Dissertation, Université de Paris X-Nanterre.

Díaz-Andreu, M. 2007. *A World History of Nineteenth Century Archaeology. Nationalism, Colonialism, and the Past*. Oxford: Oxford University Press.

Dibble, H.L. 1981. Technological Strategies of Stone Tool Production at Tabun Cave (Israel). Unpublished Doctoral Dissertation, University of Arizona.

Dibble, H.L. 1984. Interpreting Typological Variation of Middle Paleolithic Scrapers: Function, Style, or Sequence of Reduction. *Journal of Field Archaeology* 11: 431-436.

Dibble, H.L. 1987. The Interpretation of Middle Paleolithic Scraper Morphology. *American Antiquity* 52: 109-117.

Dibble, H.L. 1988. The Interpretation of Middle Paleolithic Scraper Reduction Patterns. In: L.R. Binford, J.-P. Rigaud (eds.), *L'homme de Néandertal, Vol. 4 : La technique*, pp. 49-58. Liège: ERAUL 31.

Dibble, H.L. 1991a. Mousterian assemblage variability on an interregional scale. J*ournal of Anthropological Research* 47: 239-258.

Dibble, H.L. 1991b. Local Raw Material Exploitation and its Effects on Lower and Middle Paleolithic Assemblage Variability. In: A. Montet-White, S. Holen (eds.), *Raw Material Economies among Prehistoric Hunter-Gatherers*, pp. 33-47. Lawrence: University of Kansas Publications in Anthropology.

Dibble, H.L. 1991c. Rebuttal to Close. *Journal of Field Archaeology* 18(2): 264-267.

Dibble, H.L. 1995a. Biache Saint-Vaast, Level IIA: A Comparison of Analytical Approaches. In: H.L. Dibble, O. Bar-Yosef (eds.), *Definition and Interpretation of Levallois Technology*, pp. 93-115. Madison: Prehistory Press.

Dibble, H.L. 1995b. Middle Paleolithic Scraper Reduction: Background, Clarification, and Review of the Evidence to Date. *Journal of Archaeological Method and Theory* 2(4): 299-368.

Dibble, H.L. 1995c. Raw material availability, intensity of utilization, and Middle Paleolithic assemblage variability. In: H.L. Dibble, M. Lenoir (eds.), *The Middle Paleolithic Site of Combe-Capelle Bas (France)*, pp. 289-315. Philadelphia: The University Museum, University of Pennsylvania.

Dibble, H.L. 2008. Non-Anthropological Approaches to Understanding Lithic Variability. In: A.P. Sullivan III (ed.), *Archaeological Concepts for the Study of the Cultural Past*, pp. 85-107. Salt Lake City: University of Utah Press.

Dibble, H.L., J. Whittaker 1981. New experimental evidence on the relation between percussion flaking and flake variation. *Journal of Archaeological Science* 6: 283-296.

Dibble, H.L., S.J.P. McPherron 1988. On the Computerization of Archaeological Projects. *Journal of Field Archaeology* 15: 431-440.

Dibble, H.L., S. Holdaway 1990. The Middle Paleolithic of Warwasi Rockshelter and its Relationship to the Zagros and Levantine Mousterian. *L'anthropologie* 94(4): 619-642.

Dibble, H.L., A. Debenath 1991. Paradigmatic differences in a collaborative research project. In: G.A. Clark (ed.), *Perspectives on the Past*, pp. 217-226. Philadelphia: University of Pennsylvania Press.

Dibble, H.L., O. Bar-Yosef 1993. Definition and Interpretation of Levallois Technology. *Evolutionary Anthropology* 2(3): 77.

Dibble, H.L. O. Bar-Yosef (eds.) 1995. *The Definition and Interpretation of Levallois Technology*. Madison: Prehistory Press.

Dibble, H.L., A.W. Pelcin 1995. The effect of hammer mass and velocity on flake weight. *Journal of Archaeological Science* 22(3): 429-439.

Dibble, H.L., Z. Rezek 2009. Introducing a new experimental design for controlled studies of flake formation: results for exterior platform angle, platform depth, angle of blow, velocity, and force. *Journal of Archaeological Science* 36: 1945-1954.

Dibble, H.L., S.J.P. McPherron 2018. Preface. In: H.L. Dibble, S.J.P. McPherron, P. Goldberg, D.M. Sandgate (eds.), *The Middle Paleolithic Site of Pech de l'Azé IV*, pp. ix-xvii. New York: Springer.

Dibble, H.L., U.A. Schurmans, R.P. Iovita, M.V. McLaughlin 2005. The Measurement and Interpretation of Cortex in Lithic Assemblages. *American Antiquity* 70(3): 545-560.

Dibble, H.L., S.J.P. McPherron, P. Chase, W.F. Ferrand, A. Debénath 2006. Taphonomy and the Concept of Paleolithic Cultures: The Case of the Tayacian from Fontéchevade. *PaleoAnthropology* 2006: 1-21.

Dibble, H.L., S.J. Holdaway, S.C. Lin, D.R. Braun, M.J. Douglass, R. Iovita, S.P. McPherron, D.I. Olszewski, D. Sandgathe 2017. Major Fallacies Surrounding Stone Artifacts and Assemblages. *Journal of Archaeological Method and Theory* 24(3): 813-851.

Di Méo, G. 2008. La géographie culturelle : quelle approche sociale ? *Annales de géographie* 660-661: 47-66.

Discamps, E., M.-C. Soulier, F. Bachellerie, J.-G. Bordes, J.-C. Castel, E. Morin 2014. Des faunes et des hommes : interactions entre environnements et cultures à la fin du Paléolithique moyen et au début du Paléolithique supérieur dans le Sud-Ouest de la France. In: J. Jaubert, N. Fourment, P. Depaepe (eds.), *Transitions, ruptures et continuité en Préhistoire : Volume 2, Paléolithique et Mésolithique*, pp. 299-314. Paris: Société préhistorique française.

Djindjian, F. 2009. The Golden Years for Mathematics and Computers in Archaeology (1965–1985). *Archeologia e Calcolatori* 20: 61-73.

Djindjian, F. 2013. Us et abus du concept de "chaîne opératoire" en archéologie. In: S. Krausz, A. Clon, K. Gruel, I. Ralston, T. Dechezleprêtre (eds.), *L'âge du Fer en Europe - Mélanges offerts à Olivier Buchsenschutz*, pp. 93-107. Bordeaux: Éditions Ausonius.

Djindjian, F. 2016. The Revolution of the Sixties in Prehistory and Protohistory. In: G. Delley, M. Díaz-Andreu, F. Djindjian, V.M. Fernández, A. Guidi, M-A. Kaeser (eds.), *History of Archaeology: International Perspectives*, pp. 125-144. Oxford: Archaeopress

Dobres, M.-A. 1995. *Gender in the making: Late Magdalenian social relations of production in the French Midi-Pyrenees*. Unpublished Doctoral Dissertation, University of California-Berkeley.

Donald, H., G. Maschner (eds.) 1996. *Darwinian Archaeologies*. New York: Springer.

Donnart, K. 2010. L'analyse des unités techno-fonctionnelles appliquée à l'étude du macro-outillage néolithique. *L'Anthropologie* 114 : 179-198.

Doolittle, W.E. 2016. Karl W. Butzer: Interdisciplinary mentor. *PNAS* 113(41): 11382-11383.

Dreyfus, J. 1975. *Implications ou neutralités des méthodes statistiques appliquées aux sciences humaines. L'analyse des correspondances*. Paris: CREDOC.

Dubois, S., F. Bon 2006. Henri Breuil et les origines de la « bataille aurignacienne ». In: N. Coye (ed.), *Sur les chemins de la Préhistoire. L'abbé Breuil du Périgord à l'Afrique du Sud*, pp. 135-147. Paris: Somogy.

Ducasse, S. 2010. *La "parenthèse" badegoulienne: fondements et statut d'une discordance industrielle au travers de l'analyse techno-économique de plusieurs ensembles lithiques méridionaux du Dernier Maximum Glaciaire*. Unpublished Doctoral Dissertation, Université de Toulouse II-le Mirail.

Ducasse, S. 2012. What is left of the Badegoulian "interlude"? New data on cultural evolution in southern France between 23,500 and 20,500 cal. BP. *Quaternary International* 272-273: 150-165.

Ducasse, S., M. Langlais 2008. Interprétation technologique et discussion autour du statut culturel des "pièces de la Bertonne": l'exemple de la série lithique de Seyresse (Landes, France). *Paléo* 20: 59-88.

Ducasse, S., C. Renard 2012. De 20 000 à 18 000 BP en Quercy : apports de la séquence du Cuzoul de Vers à la compréhension de l'évolution des comportements socio-économiques entre Solutréen récent et Badegoulien. In: J. Clottes, J.-P. Giraud, P. Chalard (eds.), *Diversités et identités des groupes solutréens et badegouliens en Quercy. L'exemple de l'abri du Cuzoul de Vers (Lot)*, pp. 459-471. Liège: ERAUL 131.

Ducasse, S., C. Renard, M. Baumann, J.-C. Castel, F.-X. Chauviere, C. Peschaux, J.-M. Pétillon 2016. Pour une palethnologie du pauvre : apports des séquences du sud-ouest français à la définition des comportements techno- et socio-économiques lors de la transition solutréo-badegoulienne. *Paper given at the XXVIIIe Congrès Préhistorique de France, Préhistoire de l'Europe du Nord-Ouest : mobilités, climats et identités culturelles*, 30 mai – 4 juin 2016, Amiens.

Dunbar, R.I.M. 1992. Neocortex size as a constraint on group size in primates. *Journal of Human Evolution* 22: 469-493.

Dunn, M.D. 2016. *Reviving the Organismic Analogy in Sociology: Human Society as an Organism*. Unpublished Doctoral Dissertation, University of California Riverside.

Dunnell, R.C. 1978. Style and Function: A Fundamental Dichotomy. *American Antiquity* 43(2): 192-202.

Dunnell, R.C. 1986. Five Decades of American Archaeology. In: D.J. Meltzer, D.D. Fowler, J.A. Sabloff (eds.), *American Archaeology Past and Future*, pp. 23-49. Washington D.C.: Smithsonian Institution Press.

Dunnell, R.C. 1989. Aspects of the Application of Evolutionary Theory in Archaeology. In: C.C. Lamberg-Karlovsky (ed.), *Archaeological Thought in America*, pp. 35-49. Cambridge: Cambridge University Press.

Dunnell, R.C. 1992. The Notion Site. In: J. Rossignol, L. Wandsnider (eds.), *Space, Time, and Archaeological Landscapes*, pp. 21-41. New York: Springer.

Dunnell, R.C., W.S. Dancey 1983. The Siteless Survey: A Regional Scale Data Collection Strategy. *Advances in Archaeological Method and Theory* 6: 267-287.

Dupré, J. 1993. *The Disorder of Things: Metaphysical Foundations of the Disunity of Science*. Cambridge (MA): Harvard University Press.

Durkheim, É. 1992 [1894]. *Les Règles de la méthode sociologique*. Paris: PUF.

Dybicz, P., L. Pyles 2011. The Dialectic Method: A Critical and Postmodern Alternative to the Scientific Method. *Advances in Social Work* 12(2): 301-317.

Ebert, J.I. 1992. *Distributional Archaeology*. Albuquerque: University of New Mexico Press.

Edinborough, K.S.A., S. Shennan, E. Crema, T. Kerig 2015. An ABC of lithic arrowheads: A case study from south-eastern France. In: K. Brink, S. Hydén, K. Jennbert, L. Larsson, D. Olausson (eds.), *Neoltihic Diversities*, pp. 213-223. Lund: Acta Archaeologica Lundensia 80/65.

Eerkens, J.W., C.P. Lipo 2007. Cultural Transmission Theory and the Archaeological Record: Providing Context to Understanding Variation and Temporal Changes in Material Culture. *Journal of Archaeological Research* 15(3): 239-274.

Efron, A. 1980. Introduction: Pepper's continuing value. *Paunch* 53-54: 5-53.

Egeland, C.P. 2008. Patterns of early hominid site use at Olduvai Gorge. *Mitteilungen der Gesellschaft für Urgeschichte* 17: 9-37.

Eldredge, N., S.J. Gould 1972. Punctuated equilibria: an alternative to phyletic gradualism. In: T.J.M. Schopf (ed.), *Models in Paleobiology*, pp. 82-115. San Francisco: Freeman Cooper.

Elgin, C.Z. 2005. Non-foundationalist Epistemology: Holism, Coherence, and Tenability. In: M. Steup, E. Sosa. (eds.) *Contemporary Debates in Epistemology*, pp. 156-167. Malden: Blackwell.

Elias, N. [1939] 1969. *Über den Prozess der Zivilisation*. Bern: Francke.

Ellul, J. 1977. *Le système technicien*. Paris: Calmann-Lévy.

Elston, R., P.J. Brantingham 2002. Microlithic technology in North Asia: A risk-minimizing strategy of the late Pleistocene and early Holocene. In R. Elston, S.L. Kuhn (eds.), *Thinking small: Global perspectives on microlithization*, pp. 103-116. Washington D.C.: American Anthropological Association.

Eren, M.I., S.J. Lycett 2012. Why Levallois? A Morphometric Comparison of Experimental 'Preferential' Levallois Flakes versus Debitage Flakes. *PLoS ONE* 7(1): e29273.

Eren, M.I., M. Dominguez-Rodrigo, S.L. Kuhn, D.S. Adler, I. Le, O. Bar-Yosef 2005. Defining and measuring reduction in unifacial stone tools. *Journal of Archaeological Science* 32: 1190-1201.

Eren, M.I., A. Greenspand, C.G. Sampson 2008. Are Upper Paleolithic blade cores more productive than Middle Paleolithic discoidal cores? A replication experiment. *Journal of Human Evolution* 55(6): 952-961.

Eren, M.I., S.J. Lycett, R.J. Patten, B. Buchanan, J. Pargeter, M.J. O'Brien 2016. Test, Model, and Method Validation: The Role of Experimental Stone Artifact Replication in Hypothesis-driven Archaeology, *Ethnoarchaeology* 8(2): 103-136.

Eriksen, T.H., F.S. Nielsen 2001. *A History of Anthropology*. London: PLUTO PRESS.

Etxeberria, A. 2018. Canguilhem and the logic of life. *Transversal: International Journal for the Historiography of Science*, in press.

Everson, A., P. FitzGerald 1969. *Settlement Patterns: Concepts in geography 1*. London: Longman.

Fagan, B.M. 1999. Grahame Clark and American Archaeology. *Proceedings of the British Academy* 66: 67-74.

Fagan, B.M. 2005. *A Brief History of Archaeology: From Classical Times to the Twenty-First Century*. Upper Saddle River (NJ): Pearson Prentice Hall.

Fagan, M. 2012. Collective Scientific Knowledge. *Philosophy Compass* 7(12): 821-831.

Fagnard, J.-P. 1984. *Le Paléolithique supérieur dans le Nord de la France et le Bassin de la Somme*. Unpublished Doctoral Dissertation, Université des Sciences et Techniques de Lille.

Fagnard, J.-P. 1988. *Les industries lithiques du Paléolithique supérieur dans le Nord de la France*. Numéro spécial de la Revue archéologique de Picardie.

Faivre, J.-P. 2008. *Organisation techno-économique des systèmes de production dans le Paléolithique moyen récent du Nord-est Aquitain : Combe-Grenal et les Fieux*. Doctoral Dissertation, Université de Bordeaux.

Faivre, J.-P. 2012. A material anecdote but technical reality. Bladelet and small blade production during the recent Middle Paleolithic Combe-Grenal rock shelter. *Lithic Technology* 37(1): 5-25.

Farizy, C. (ed.) 1990. *Paléolithique moyen récent et Paléolithique supérieur en Europe. Ruptures et transitions : examen critique des documents archéologiques*. Paris: Association pour la promotion de la recherche archéologique en Île-de-France.

Febvre, L. 1988. Zur Entwicklung des Wortes und der Vorstellung von ›Civilisation‹. In: L. Febvre (ed.), *Das Gewissen des Historikers*, pp. 39-77. Berlin: Wagenbach.

Feder Kittay, E. 1987. *Metaphor. Its Cognitive Force and Linguistic Structure*. Oxford: Clarendon Press.

Feibleman, J.K. 1962. Nominalism. In: D.D. Runes (ed.), *Dictionary of Philosophy*, p. 211.Totowa (NJ): Littlefield.

Feigl, H. 1943. Logical Empiricism. In: D.D. Runes (ed.), *Twentieth Century Philosophy*, pp. 371-416. New York: Philosophical Library.

Finlayson, J.C. 2004. *Neanderthals and Modern Humans. An Ecological and Evolutionary Perspective*. Cambridge: Cambridge University Press.

Finlayson, J.C. 2008. On the importance of coastal areas in the survival of Neanderthal populations during the Late Pleistocene. *Quaternary Science Reviews* 27: 2246-2252.

Finlayson, J.C. 2009. *The Humans Who became extinct: Why Neanderthals Died Out and We Survived*. Oxford: Oxford University Press.

Finlayson, J.C. 2013. The Water Optimisation Hypothesis and the human occupation of the mid-latitude belt in the Pleistocene. *Quaternary International* 300: 22-31.

Finlayson, J.C. 2014. *The Improbable Primate: How Water Shaped Human Evolution*. Oxford: Oxford University Press.

Finlayson, J.C., J.S. Carrión 2007. Rapid ecological turnover and its impact on Neanderthal and other human populations. *TRENDS in Ecology and Evolution* 22(4): 213-222.

Finlayson, J.C., D.A. Fa, G. Finlayson 2000. Biogeography of human colonizations and extinctions in the Pleistocene. *Memoirs Gibcemed* 1: 1-69.

Finlayson, J.C., J. Rodriguez Vidal, D. Francisco Giles Pacheco (eds.) 2012. Where the Last Neanderthals Lived: A Study of Neanderthal and Modern Human Behavioural Ecology in a Glacial Refugium. Oxford: Oxbow Books.

Firth, R. 1939. *Primitive Polynesian Economy*. London: Routledge.

Firth, R. (ed.) 1967. *Themes in Economic Anthropology*. London: Tavistock.

Fitzhugh 2001. Risk and Invention in Human Technological Evolution. *Journal of Anthropological Archaeology* 20: 125-167.

Flannery, K.V. 1968. Archaeological Systems Theory and Early Mesoamerica. In: B.J. Meggers (ed.), *Anthropological Archaeology in the Americas*, pp. 67-87. Washington: Anthropological Society of Washington.

Fleck, L. 1935 [1979]. *Entstehung und Entwicklung einer wissenschaftlichen Tatsache*. Frankfurt a. Main: Suhrkamp. [Quoted English Version: *Genesis and Development of a Scientific Fact,* edited by T.J. Trenn and R.K. Merton, translated by F. Bradley and T.J. Trenn, Chicago: University of Chicago Press]

Fleck, L. 1936. Zagadnienie toerii poznawania [Das Problem einer Theorie des Erkennens]. *Przegląd Filozoficzny* 39(1): 3-37.

Fodor, J. 1974. Special Sciences: Or the Disunity of Science as a Working Hypothesis. *Synthese* 28: 97-115.

Foley, R.A. 1981. *Off-site archaeology and human adaptation in Eastern Africa: an analysis of regional artifact density in the Amboseli, Southern Kenya*. BAR International Series 97. Oxford: Archaeopress.

Foley, R.A. 1987. Hominid Species and Stone-Tool Assemblages: How are they related? *Antiquity* 61: 380-392.

Foley, R.A., P.C. Lee 1989. Finite Social Space, Evolutionary Pathways, and Reconstructing Hominid Behavior. *Science* 243: 901-906.

Foley, R.A., P.C. Lee 1996. Finite social space and the evolution of human social behaviour. In: J. Steele, S. Shennan (eds.), *The Archaeology of Human Ancestry: Power, Sex and Tradition*, pp. 47-66. London: Routledge.

Foley, R.A., M.M. Lahr 2003. On Stony Ground: Lithic Technology, Human Evolution, and the Emergence of Culture. *Evolutionary Anthropology* 12: 109-122.

Foley, R.A., J.M. Maíllo-Fernández, M. Mirazón Lahr 2013. The Middle Stone Age of the Central Sahara: biogeographical opportunities and technological strategies in later human evolution. *Quaternary International* 300: 153-170.

Forber, P. 2008. Forever beyond our grasp? *Biology and Philosophy* 23: 135-141.

Forber, P., E. Griffith 2011. Historical reconstruction: Gaining access to the deep past. *Philosophy and Theory in Biology* 3: 1-19.

Forestier, H. 1992. *Approche technologique de quelques séries dites clactoniennes du nord-ouest de la France et du sud-est de l'Angleterre*. Unpublished Master Dissertation (Mémoire de Maîtrise), Université Paris X-Nanterre.

Forestier, H. 1993. Le Clactonien : mise en application d'une nouvelle méthode de débitage s'inscrivant dans la variabilité des systèmes de production lithique du Paléolithique ancien. *Paléo* 5: 53-82.

Forestier, H. 1998. *Technologie et typologie de la pierre taillée de deux sites holocènes des montagnes sud de java (Indonésie)*. Unpublished Doctoral Dissertation, Muséum national d'histoire naturelle (Paris).

Forestier, H. 2000. De quelques chaînes opératoires lithiques en Asie du Sud-Est au pléistocène supérieur final et au début de l'holocène. *L'Anthropologie* 104(4): 531-548.

Forestier, H. 2010. *La pierre et son ombre : réflexion sur le phénomène hoabinhien d'Asie du sud-est*. Habilitation, Université de Paris X-Nanterre.

Forestier H., T. Simanjuntak, F. Détroit, V. Zeitoun 2010. Unité et diversité préhistorique entre Java et Sumatra. *Archipel* 80: 19-44.

Foucault, M. 1969. *L'Archéologie du savoir*. Paris: Gallimard.

Foucault, M. 1972. *L'ordre du discours: Leçon inaugurale au Collège de France prononcée le 2 décembre 1970*. Paris: Gallimard.

Fox, R. (ed.) 1975. *Biosocial Anthropology*. London: Malaby Press.

Fox, R. 1989. *The Search for Society. Quest for a Biosocial Science and Morality*. New Brunswick: Rutgers University Press.

Freeman, C. 1994. The economics of technical change. *Cambridge Journal of Economics* 18(5): 463-514.

Freeman, L.G. 1966. The Nature of Mousterian Facies in Cantabria. *American Anthropologist* 68: 230-237.

Freeman, L.G. 2009. *Anthropology without Informants. Collected Works in Paleoanthropology by L.G. Freeman*. Boulder: University of Colorado Press.

Frison, G. 1968. A functional analysis of certain chipped stone tools. *American Antiquity* 33: 149-155.

Fumerton, R. 2002. *Realism and the Correspondence Theory of Truth*. Lanham: Rowman & Littlefield.

Furet, F. 1975. From Narrative History to History as a Problem. *Diogenes* 89: 106-123.

Gadamer, H.-G. 1960. *Gesammelte Werke 1 – Hermeneutik I*. Tübingen: Mohr.

Gallay, A. 1991. *Itinéraires ethnoarchéologiques, tome 1*. Genève: Départment d'anthropologie et d'écologie de l'université de Genève.

Gallay, A. 2003. Reconstituer la vie, André Leroi-Gourhan et la lecture des archives archéologiques. *Revue archéologique de Picardie* 21: 51-68.

Gallay, A. 2011. *Pour une ethnoarchéologie théorique*. Paris: Éditions errance.

Gallay, A. 2015. Retour à la Civilisation du renne : à propos du livre Un automne à Pincevent. *Bulletin de la Société Préhistorique Française* 112(1): 139-144.

Gallay, A., F. Audouze, V. Roux (eds.) 1992. Ethnoarchéologie, justification, problèmes, limites. Juan-les-Pins: Éditions APDCA.

Galison, P. 1997. *Image & logic: A material culture of microphysics*. Chicago: University of Chicago Press.

Galison, P., D.J. Stump (eds.) 1996. *The Disunity of Science. Boundaries, Contexts, and Power*. Stanford: Stanford University Press.

Gamble, C. 1986. *The Palaeolithic Settlement of Europe*. Cambridge: Cambridge University Press.

Gamble, C. 1998. Palaeolithic society and the release from proximity: a network approach to intimate relations. *World Archaeology* 29(3): 426-449.

Gamble, C. 1999. *The Palaeolithic Societies of Europe*. Cambridge: Cambridge University Press.

Gamble, C. 2001. *Archaeology: The Basics*. London: Routledge.

Gamble, C. 2007. *Origins and Revolutions: Human Identity in Earliest Prehistory*. Cambridge: Cambridge University Press

Gamble, C., J.A.S. Gowlett, R.I.M. Dunbar 2011. The Social Brain and the Shape of the Palaeolithic. *Cambridge Archaeological Journal* 21(1): 115-135.

Gamble, C., J.A.J. Gowlett, R.I.M. Dunbar 2014. *Thinking Big. How the Evolution of Social Life Shaped the Human Mind*. London: Thames & Hudson.

Garrard, N.A., B.F. Byrd (eds.) 2013. *Beyond the Fertile Crescent. Late Palaeolithic and Neolithic communities of the Jordanian Steppe*. Oxford/Oakville: Oxbow Books.

Gaver, W.W. 1991. Technology Affordances. In: *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems: Reaching through Technology*, pp. 78-94. New Orelans (LA): ACM Press.

Gazagnadou, D. 2008. *La diffusion des techniques et les cultures*. Paris: Klimé.

Geertz, C. 1977. *The Interpretation of Cultures*. New York: Basic Books.

Geneste, J.-M. 1985. *Analyse lithique d'industries Moustériennes du Périgord : une approche technologique du comportement des groupes humains au Paléolithique Moyen*. Unpublished Doctoral Dissertation, Université de Bordeaux I.

Geneste, J.-M. 1988. Systèmes d'approvisionnement en matières premières au Paléolithique moyen et au Paléolithique supérieur en Aquitaine. In: J.K. Kozlowski (ed.), *L'Homme de Néandertal, vol. VIII: La mutation*, pp. 61-70. Liège: ERAUL 35.

Geneste, J.-M. 1989. Economie des ressources lithiques dans le Moustérien du Sud-Ouest de la France. In: M. Otte (ed.), *L'Homme de Néandertal*, pp. 75-97. Liège: ERAUL.

Geneste, J.-M. 1991. Systèmes techniques de production lithique. Variations techno-économiques dans les processus de réalisation des outillages paléolithiques. *Techniques & Culture* 17-18: 1-35.

[Geneste, J.-M. 2010. Systèmes techniques de production lithique. Variations techno-économiques dans les processus de réalisation des outillages paléolithiques. *Techniques & Culture* 54-55(2): 419-449.]

Geneste J.-M., H. Plisson 1986. Le Solutréen de la grotte de Combe Saunière 1 (Dordogne). Première approche palethnologique. *Gallia préhistoire* 29(1): 9-27.

Geneste, J.-M., S. Maury 1997. Contributions of Multidisciplinary Experimentation to the Study of Upper Paleolithic Projectile Points. In: H. Knecht (ed.), *Projectile Technology*, pp. 165-189. New York: Springer.

Geneste, J.-M., J. Jaubert 1999. Les sites paléolithiques à grands bovidés et les assemblages lithiques: chronologie, techno-économie et cultures. In: J.P. Brugal, F. David, J.G. Enloe, J. Jaubert (eds.), *Le Bison: gibier et moyen de subsistance des hommes du Paléolithique aux Paléoindiens des Grandes Plaines*, pp. 185-214. Antibes: APDCA.

Geneste, J.-M., J. Jaubert, M. Lenoir, L. Meignen, A. Turq 1997. Approche technologique des Moustériens Charentiens du Sud-Ouest de la France et du Languedoc oriental. *Paléo* 9: 101-142.

Genette, G. 1982. *Palimpsestes. La Littérature au second degré*. Paris: Éditions du Seuil.

Gerhardt, U. 2001. *Idealtypus. Zur methodischen Begründung der modernen Soziologie*. Baden-Baden: Suhrkamp.

Gettier, E.L. 1963. Is Justified True Belief Knowledge? *Analysis* 23(6): 121-123.

Geyer, P. 2010. *Zur Dialektik von Kultur und Zivilisation in einer Kritischen Kulturwissenschaft*. Unpublished manuscript presented at "Global Concepts? Keywords and Their Histories in Asia and Europe," University of Heidelberg, 28.10.2010 [URL= https://www.romanistik.uni-bonn.de/bonner-romanistik/personal/geyer/schriften/dialektik.pdf].

Gibbon, G. 2005. Epistemology. In: C. Renfrew, P. Bahn (eds.), *Archaeology: The Key Concepts*, pp. 67-71. London: Routledge.

Gibson, J.J. 1977. The Theory of Affordances. In: R. Shaw, J. Bransford (eds.), *Perceiving, acting, and knowing: Toward an ecological psychology*, pp. 67-82. Mahwah (NJ): Lawrence Erlbaum Associates.

Gibson, J.J. 1979. *The Ecological Approach to Visual Perception*. Boston (MA): Houghton Mifflin.

Giere, R.N. 2011. History and philosophy of science: Thirty-five years later. In: S. Mauskopf, T. Schmaltz (eds.), *Integrating history and philosophy of science*, pp. 59-65. Dordrecht: Springer.

Gigerenzer, G. 2007. *Gut Feelings*. New York: Viking.

Gijsbers, V. 2013. Understanding, explanation, and unification. *Studies in History and Philosophy of Science* 44: 516-522.

Gille, B. 1978. *Histoire des techniques*. Paris: Gallimard.

Gillespie, D. 1982. *An Interpretation of Some Metatheoretical Assumptions in Cognitive Psychology: Mechanism and Contextualism*. Unpublished Doctoral Dissertation, University of Nebraska.

Godelier, M. 1999. *The Enigma of the Gift*. Cambridge: Polity.

Godelier, M. 2007. *Au fondement des sociétés humaines : ce que nous apprend l'anthropologie*. Paris: Albin Michel.

Godfrey-Smith, P. 2003. *Theory and Reality. An Introduction to the Philosophy of Science*. Chicago: University of Chicago Press.

Godfrey-Smith, P. 2008. Recurrent transient underdetermination and the glass half full. *Philosophical Studies* 137: 141-148.

Goerner, S.J. 1992. *The evolving ecological universe: A study in the science and human implications of a new world hypothesis*. Unpublished Doctoral Dissertation, Saybrook Institute (San Francisco).

Goff, P., W. Seager, S. Allen-Hermanson 2017. Panpsychism. In: E.N. Zalta (ed.), *The Stanford Encyclopedia of Philosophy (Winter 2017 Edition)*, URL = https://plato.stanford.edu/archives/win2017/entries/panpsychism/ [last access 15.02.2018].

Goffman, E. 1963. *Stigma. Notes on the management of spoiled identity*. Englewood-Cliffs (NJ): Prentice-Hall.

Goffman, E. 1974. *Frame Analysis: An Essay on the Organization of Experience*. New York: Harper & Row.

Goldman, A.I. 1967. A Causal Theory of Knowing. *The Journal of Philosophy* 64(12): 357-372.

Goldratt, E.M. 1990. *What is this thing called the Theory of Constraints?* Croton-on-Hudson (NY): North River Press.

Goldratt, E.M. 1996. Focusing on constraints, not costs. In: R. Gibson (ed.), *Rethinking the Future. Rethinking Business Principles, Competition, Control and Complexity, Leadership, Markets and the World*, pp. 106-120. London: Nicholas Brealey Publishing Ltd.

Goodale, N., W. Andrefsky Jr. (eds.) 2015. *Lithic Technological Systems and Evolutionary Theory*. Cambridge: Cambridge University Press.

Gooding, D. 2004. Cognition, Construction, and Culture: Visual Theories in the Sciences. *Journal of Cognition and Culture* 4: 551-593.

Goodman, N. 1965. *Fact, Fiction, and Forecast*. New York: Bobbs-Merrill.

Goodrum, M.R. 2009. The History of Human Origins Research and Its Place in the History of Science: Research Problems and Historiography. *History of Science* 47(3): 337-357.

Goodrum, M.R. 2014. Crafting a New Science. Defining Paleoanthropology and Its Relationship to Prehistoric Archaeology, 1860–1890. *Isis* 105: 706-733.

Gopnik, A., E. Schwitzgebel 1998. Whose Concepts Are They, Anyway? The Role of Philosophical Intuition in Empirical Psychology. In: M.R. DePaul, W. Ramsey (eds.), *Rethinking Intuition*, pp. 75-91. Lanham: Rowman & Littlefield.

Goval, E., D. Hérisson, J.-L. Locht, A. Coudenneau 2016. Levallois points and triangular flakes during the Middle Palaeolithic in northwestern Europe: Considerations on the status of these pieces in the Neanderthal hunting toolkit in northern France. *Quaternary International* 411: 216-232.

Gowlett, J.A.J. 1984. Mental abilities of early man. *Higher Education Quarterly* 38(3): 199-220.

Gowlett, J.A.J. 1996. The framework of early hominid social systems: How many useful parameters of archaeological evidence can we isolate? In: J. Steele, S. Shennan (eds.), *The Archaeology of Human Ancestry: Power, sex and tradition* , pp. 124-168. London: Routledge.

Gowlett, J.A.J. 2002. Apes, Hominids and Technology. In: C.S. Harcourt, B.R. Sherwood (eds.), *New perspectives in primate evolution and behaviour*, pp. 147-171. London/Otley: Westbury Academic and Scientific Publishing.

Gowlett, J.A.J. [2014] 2006. The Elements of Design Form in Acheulean Bifaces: Modes, Modalities, Rules, and Language. In: N. Goren-Inbar, G. Sharon (eds.), *Axe Age: Acheulian Tool-making from Quarry to Discard*, pp. 203-221. London: Equinox

Gowlett, J.A.J. 2009. Artefacts of apes, humans, and others: towards comparative assessment and analysis. *Journal of Human Evolution* 57(4): 401-410.

Gowlett, J.A.J. 2010. The Future of Lithic Analysis in Palaeolithic Archaeology: A View from the Old World. In: S.J. Lycett, P.R. Chauhan (eds.), *New Perspectives on Old Stones. Analytical Approaches to Paleolithic Technologies*, pp. 295-309. New York: Springer.

Gowlett, J.A.J. 2015. Variability in an early hominin percussive tradition: the Acheulean versus cultural variation in modern chimpanzee artefacts. *Philosophical Transactions of the Royal Society London* B 370: 20140358.

Gowlett, J.A.J., C. Gamble, R.I.M. Dunbar 2012. Human evolution and the archaeology of the social brain. *Current Anthropology* 53: 693-722.

Gould, S.J. 1965. Is uniformitarianism necessary? *American Journal of Science* 263: 223-228.

Gould, S.J. 1987. *Time's Arrow, Time's Cycle. Myth and Metaphor in the Discovery of Geological Time*. Cambridge (MA): Harvard University Press.

Gramsci, A. 1971. *Selections from the Prison Notebooks*. Edited and translated by Q. Hoare and G.N. Smith. New York: International Publishers.

Grehan, J.R., R. Ainsworth 1985. Orthogenesis and Evolution. *Systematic Zoology* 34(2): 174-192.

Grene, M. 1958. Two evolutionary theories. *British Journal for the Philosophy of Science* 9: 185-193, 110-127.

Grene, M. 1974. *The understanding of nature: Essays in the philosophy of biology*. Dordrecht: D. Reidel.

Grene, M. 1989. Interaction and evolution. In: M. Ruse (ed.), *What the philosophy of biology is: Essays dedicated to David Hull*, pp. 67-73. Dordrecht: D. Reidel.

Grene, M. 1990. Evolution, typology, and population thinking. *American Philosophical Quarterly* 27: 237-244.

Grene, M. 2002. Reply to David Hull. In: R.E. Auxhier, L.E. Hahn (eds.), *The Philosophy of Marjorie Grene*, pp. 279-283. Chicago: Open Court.

Greve, J., A. Schnabel 2011. Einleitung. In: J. Greve, A. Schnabel (eds.), *Emergenz. Zur Analyse und Erklärung komplexer Strukturen*, pp. 1-35. Berlin: Suhrkamp.

Groenen, M. 1994. *Pour une histoire de la préhistoire. Le paléolithique*. Grenoble: Éditions Jérôme Millon.

Groenen, M. 1996. *André Leroi-Gourhan : essence et contingence dans la destinée humaine*. Louvain-la-Neuve: De Boeck-Université

Grove, M. 2008. Hunter-gatherer movement patterns: Causes and constraints. *Journal of Anthropological Archaeology* 28: 222-233.

Grove, M. 2010. Logistical mobility reduces subsistence risk in hunting economies. *Journal of Archaeological Science* 37: 1913-1921.

Groucutt, H.S., E.S. Scerri, L. Lewis, L. Clark-Balzan, J. Blinkhorn, R.P. Jennings, A. Parton, M.D. Petraglia 2015. Stone tool assemblages and models for the dispersal of Homo sapiens out of Africa. *Quaternary International* 382: 8-30.

Grüne-Yanoff, P. Weirich 2010. The Philosophy and Epistemology of Simulation: A Review. *Simulation & Gaming* 41(1): 20-50.

Guchet, X. 2008. Évolution technique et objectivité technique chez Leroi-Gourhan et Simondon. *Appareil 2* [URL = http://revues.mshparisnord.org/appareil/index.php?id=580, accessed on the 30.12.2017].

Guillomet-Malmassari, V. 2012. *D'une révolution à l'autre. Pour une épistémologie de la problématique de transition en Préhistoire*. Paris: Société Préhistorique Française.

Gunderson, L.H. 2000. Ecological Resilience—In Theory and Application. *Annual Review of Ecology and Systematics* 31: 425-439.

Habermas, J. 1968. *Erkenntnis und Interesse*. Frankfurt am Main: Suhrkamp.

Habermas, J. 1981. *Theorie des kommunikativen Handelns, 2 volumes*. Frankfurt am Main: Suhrkamp.

Hacking, I. 1985. Styles of scientific thinking. In: J. Rajchman, C. West (eds.), *Postanalytic philosophy*, pp. 145-165. New York: Columbia University Press.

Hacking, I. 1996. The Disunities of the Sciences. In: P. Galison, D.J. Stump (eds.), *The Disunity of Science. Boundaries, Contexts, and Power*, pp. 37-74. Stanford: Stanford University Press.

Haggett, P. 1965. *Locational analysis in human geography*. London: E. Arnold.

Haggett, P. 1972. *Geography: a modern synthesis*. New York: Harper and Row.

Hahn, H.P. 2013. *Ethnologie. Eine Einführung*. Berlin: Suhrkamp.

Hahn, L.P. [1999] 2000. Pepper, Stephen C. (29 April 1891-01 May 1972). *American National Biography*: https://doi.org/10.1093/anb/9780198606697.article.2001677 [accessed 08.02.2018].

Halbwachs, M. 1925. *Les Cadres sociaux de la mémoire*. Paris: Albin Michel.

Halbwachs, M. 1950. *La mémoire collective*. Paris: Albin Michel.

Hammond, N., G.L. Isaac, R. Chapman, A. Sherratt, S. Shennan (eds.) 1979. *Analytical Archaeologist: Collected Papers of L. David Clarke*. London: Academic Press.

Harary, F., R.Z. Norman, D. Cartwright 1965. *Structural Models: An Introduction to the Theory of Directed Graphs*. New York: Wiley.

Harman, G.H. 1965. The Inference to the Best Explanation. The Philosophical Review 74(1): 88-95.

Harrell, B.J. 1982. The Social Basis of Root Metaphor: An Application to "Apocalypse Now" and "The Heart of Darkness". *The Journal of Mind and Behavior* 3(3/4): 221-240.

Harris, J.W.K., G.L. Issac 1976. The Karari Industry: Early Pleistocene archaeological evidence from the terrain east of Lake Turkana, Kenya. *Nature* 262: 101-107.

Harris, M., A.F. Fontana, B.N. Dowds 1977. The World Hypotheses Scale: Rationale, Reliability and Validity. *Journal of Personality Assessment* 41(5): 537-547.

Harrold, F. 1991. The Elephant and the Blind Men. In: G.A. Clark (ed.), *Perspectives on the Past*, pp. 164-182. Philadelphia: University of Pennsylvania Press.

Harrold, F. 2002. Transatlantic Prehistory: Thoughts on the Encounter Between American and European Paleolithic Prehistory. In: L.G. Straus (ed.), *The Role of American Archeologists in the Study of the European Upper Paleolithic*, pp. 27-33. BAR International Series 1048. Oxford: Archaeopress.

Haudricourt, A.-G. 1946. *Essai sur les techniques dans les sociétés pré-machinistes*. Paris: Gallimard.

Haudricourt, A.-G. 1964. La technologie, science humaine. *La Pensée* 115: 28-35.

Haudricourt, G.-A. 1987. *La Technologie science humaine*. Paris: Édition de la Maison des sciences de l'Homme.

Hawkes, C. 1954. Archaeological Theory and Method: Some Suggestions from the Old World. *American Anthropologist* 56(2): 155-168.

Hayes, S.C., L.A. Hayes, H.W. Reese 1988. Finding the Philosophical Core: A Review of Stephen C. Pepper's *World Hypotheses: A Study in Evidence*. *Journal of the Experimental Analysis of Behavior* 50: 97-111.

Heathcote, A. 1989. A Theory of Causality: Causality = Interaction (as Defined by a Suitable Quantum Field Theory). *Erkenntnis* 31: 77-108.

Heidegger, M. 2006 [1927]. *Sein und Zeit*. Tübingen: Niemeyer.

Hempel, C.G. 1942. The Function of General Laws in History. *Journal of Philosophy* 39(2): 35-48.

Hempel, C.G. 1945. Studies in the Logic of Confirmation. *Mind* 54(213): 1-26.

Hempel, C.G. 1958. The Theoretician's Dilemma. In: H. Feigl, M. Scriven, G. Maxwell (eds.), *Concepts, Theories, and the Mind-Body Problem*, pp. 37-98. Minneapolis: University of Minnesota Press.

Hempel, C.G. 1965. *Aspects of Scientific Explanation and Other Essays in the Philosophy of Science*. New York: Free Press.

Hempel, C.G. 1966. *Philosophy of Natural Science*. Englewood Cliffs: Prentice-Hall.

Hempel, C.G., P. Oppenheim 1948. Studies in the Logic of Explanation. *Philosophy of Science* 15: 135-175.

Henderson, D.K. 1994. Epistemic Competence and Contextualist Epistemology: Why Contextualism Is Not Just the Poor Man's Coherentism. *Journal of Philosophy* 91: 627-649.

Henderson, L. 2018. The Problem of Induction. In: E.N. Zalta (ed.), *The Stanford Encyclopedia of Philosophy*: URL = https://plato.stanford.edu/archives/sum2018/entries/induction-problem/ [last accessed 15.07.2018].

Henningsen, D. 2009. Aktualismus in den Geowissenschaften – Die Gegenwart als Schlüssel zur Vergangenheit. *Naturwissenschaftliche Rundschau* 62(5): 229-232.

Henry, D.O. 1973. *The Natufian of Palestine: Its Material Culture and Ecology*. Unpublished Doctoral Dissertation, Southern Methodist University, Dallas.

Henry, D.O. 1982. The prehistory of southern Jordan and relationships with the Levant. *Journal of Field Archaeology* 9: 417-444.

Henry, D.O. 1986. The prehistory and paleoenvironments of Jordan: an overview. *Paléorient* 12: 5-26.

Henry, D.O. 1987. Climatic change, settlement mobility, and technological evolution during the Paleolithic. *Israel Journal of Earth Sciences* 36: 121-129.

Henry, D.O. 1989a. *From Foraging to Agriculture*. Philadelphia: University of Pennsylvania Press.

Henry, D.O. 1989b. Correlations between Reduction Strategies and Settlement Patterns. *Archeological Papers of the American Anthropological Association* 1(1): 139-155.

Henry, D.O. (ed.) 1995. *Prehistoric Cultural Ecology and Evolution Insights from Southern Jordan*. New York: Plenum Press.

Henry, D.O. 2003. Human Behavior and the Stone Tools from Tor Faraj. In: D.O. Henry (ed.), *Neanderthals in the Levant: Behavioral Organization and the Beginnings of Human Modernity*, pp. 60-85. London/New York: Continuum.

Henry, D.O., M. Belmaker, S.M. Bergin 2017. The effect of terrain on Neanderthal ecology in the Levant. *Quaternary International* 435: 94-105.

Herskovits, M.J. 1952. *Economic Anthropology: A Study in Comparative Economics*. New York: Alfred A. Knopf.

Higgs, E.S. (ed.) 1972. *Papers in Economic Prehistory*. Cambridge: Cambridge University Press.

Higgs, E.S. (ed.) 1975. Palaeoeconomy. Cambridge: Cambridge University Press.

Higgs, E.S., M.R. Jarman 1975. Palaeoeconomy. In: E.S. Higgs (eds.), *Palaeoeconomy*, pp. 1-7. Cambridge: Cambridge University Press.

Hillmann, K.-H. 1994. *Wörterbuch der Soziologie*. Stuttgart: Kröner.

Hodder, I.R., C. Orton 1976. *Spatial analysis in archaeology*. Cambridge: Cambridge University Press.

Hodgson, D. 2009. Evolution of the visual cortex and the emergence of symmetry in the Acheulean techno-complex. *Comptes Rendus Palevol* 8(1): 93-97.

Hodgson, D. 2010. Another side of symmetry: the Acheulean biface debate. *Antiquity* 84: 325.

Hodgson, D. 2011. The first appearance of symmetry in the human lineage: where perception meets art. *Symmetry* 3: 37-55.

Hodgson, D. 2015. The symmetry of Acheulean handaxes and cognitive evolution. *Journal of Archaeological Science Reports* 2: 204-208.

Hodgson, D., J. McNabb 2005. More on Acheulean tools. *Current Anthropology* 46: 647-650.

Hodgson, G.M. 2000. The Concept of Emergence in Social Science: Its History and Importance. *EMERGENCE* 2(4): 65–77.

Hoffecker, J.F. 2001. *Desolate Landscapes: Ice Age Settlement in Eastern Europe*. New Brunswick: Rutgers University Press.

Hoffecker, J.F. 2005. *A Prehistory of the North. Human Settlement of the Higher Latitudes*. New Brunswick: Rutgers University Press.

Hoffecker, J.F. 2009. The spread of modern humans in Europe. *PNAS* 106(38): 16040-16045.

Hoffecker, J.F., S. Elias 2003. Environment and archeology in Beringia. *Evolutionary Anthropology* 12(1): 34-49.

Hoffecker, J.F., S. Elias 2007. *Human Ecology of Beringia*. New York: Columbia University Press.

Hoffecker, J.F., I.T. Hoffecker 2018. The Structural and Functional Complexity of Hunter-Gatherer Technology. *Journal of Archaeological Method and Theory* 25: 202-225.

Holdaway, S.J. 1991. *Resharpening Reduction and Lithic Assemblage Variability Across the Middle to Upper Paleolithic Transition*. Unpublished Doctoral Dissertation, University of Pennsylvania.

Holdaway, S.J., S.P. McPherron, B.J. Roth 1996. Notched tool reuse and raw material availability in French Middle Paleolithic sites. *American Antiquity* 61(2): 377-389.

Honenberger, P. 2015. Grene and Hull on types and typological thinking in biology. *Studies in History and Philosophy of Biological and Biomedical Sciences* 50: 13-25.

Hopkinson, T. 2004. Leaf Points, Landscapes and Environment Change in the European Late Middle Palaeolithic. In: N.J. Conard (ed.), *Settlement Dynamics of the Middle Paleolithic and Middle Stone Age, Volume II*, pp. 227-258. Tübingen: Kerns.

Hörisch, J. 2010. *Theorie-Apotheke. Eine Handreichung zu den humanwissenschaftlichen Theorien der letzten fünfzig Jahre, einschließlich ihrer Risiken und Nebenwirkungen*. Frankfurt am Main: Suhrkamp.

Hosfield, R., J. Cole, J. McNabb 2018. Less of a bird's song than a hard rock ensemble. *Evolutionary Anthropology Issues* 27(1) [News and Reviews]: 9-20.

Hooykaas, R. 1963. *The Principle of Uniformity in Geology, Biology, and Theology*. Leiden: E.J. Brill.

Howell, F.C. 1965. *Early Man*. New York: Time-Life Books.

Howell, F.C. 1972. Recent advances in human evolutionary studies. In: S.L. Washburn, P. Dolhinow (eds.), *Perspectives on human evolution*, Vol. 2, pp. 51-128. New York: Holt, Rhinehart and Winston.

Howell, F.C. 2003. Sherwood Larned Washburn 1911-2000. *Biographical Memoirs of the National Academy of Sciences* 84.

Hudson, C.M. 2008. Walter Taylor and the history of American archaeology. *Journal of Anthropological Archaeology* 27: 192-200.

Hull, D. 1965a. The effect of essentialism on taxonomy e two thousand years of stasis (I). *The British Journal for the Philosophy of Science* 15(60): 314-326.

Hull, D. 1965b. The effect of essentialism on taxonomy e two thousand years of stasis (II). *The British Journal for the Philosophy of Science* 16(61): 1-18.

Hull, D. 1969. What the philosophy of biology is not. *Synthese* 20(2): 157-184.

Hull, D. 1967. The metaphysics of evolution. *The British Journal for the History of Science* 3(4): 309-337.

Hull, D. 1989 [1986]. On human nature. In: *PSA 1986*, pp. 3-13. East Lansing (MI): Philosophy of Science Association.

Hull, D. 1998. Taxonomy. In: In E. Craig (ed.), *Routledge Encyclopedia of Philosophy*, pp. 272-276. London: Routledge.

Hurel, A. 2007. *La France préhistorienne, de la Révolution à 1941*. Paris: CNRS Éditions.

Hurel, A. 2011. *L'abbé Breuil. Un préhistorien dans le siècle*. Paris: CNRS Éditions.

Hurel, A., N. Coye (eds.) 2011. *Dans l'épaisseur du temps, archéologues et géologues inventent la préhistoire*. Paris: Éditions du Muséum national d'histoire naturelle (Archives).

Hussain, S.T. 2013. *Zum Problem leptolithischer Klassifikationseinheiten im Jungpaläolithikum. Eine Kritik des technotypologischen Zusammenhangs von frühem und spätem Ahmarien anhand der Fundstellen von al-Ansab 1 und Taibeh 3 (Wadi Sabra, Südjordanian)*. Unpublished Master Dissertation, University of Cologne.

Hussain, S.T. 2018. Kreativität, Technizität und Autopoiesis – Zur Bedeutung des *Homo faber* für das Verständnis der frühsten Menschheitsgeschichte. In: U. van Loyen, J.F.M. Schick, M. Schmidt, M. Zillinger (eds.), Homo faber. *ZfK – Zeitschrift für Kulturwissenschaften* 2018(2): 49-66.

Hutchby, I. 2001. Technologies, Texts and Affordances. *Sociology* 35(2): 441-456.

Huttunen, T. 2012. On the semiotic description of autogenesis in culture. *Sign Systems Studies* 40(3/4): 473-483.

Ingold, T. 2016 [1983]. *Evolution and Social Life*. London: Routledge.

Inizan, M.-L. 1976. *Nouvelle étude d'industries lithiques du Capsien*. Unpublished Doctoral Dissertation (Thèse du 3° cycle), Université de Paris X-Nanterre.

Inizan, M.-L. 1980a. Séries anciennes et économie du débitage. In: J. Tixier (ed.), *Préhistoire et Technologie lithique, 11-13 mai 1979, vol 1*, pp. 28-30. Paris: Centre régional de publication de Sophia Antipolis.

Inizan, M.-L., M. Reduron, H. Roche, J. Tixier 1995. *Technologie de la pierre taillée*. Paris: C.R.E.P.

[Inizan, M.-L., M. Reduron-Ballinger, H. Roche, J. Tixier 1999. *Technology and Terminology of Knapped Stone*. Translated by J. Féblot-Augustins. Paris: C.R.E.P.]

Isaac, G.L. 1967. Towards the interpretation of occupation debris: some experiments and observations. *Kroeber Anthropological Society Papers* 37: 31-57.

Isaac, G.L. 1972a. Chronology and the tempo of cultural change during the Pleistocene. In: W.W. Bishop, J.A. Miller (eds.), *The Calibration of Hominoid Evolution*, pp. 381-430. Edinburgh: Scottish Academic Press.

Isaac, G.L. 1972b. Early phases of human behaviour: models in Lower Palaeolithic archaeology. In: D.L. Clarke (ed.), *Models in Archaeology*, pp. 167-199. London: Methuen.

Isaac, G.L. 1976. Stages of cultural elaboration in the Pleistocene: Possible archaeological indicators of the development of language capabilities. In: S.R. Harnad, H.D. Steklis, J. Lancaster (eds.), *Annals of the New York Academy of Sciences: Origins and Evolution of Language and Speech*, pp. 275-288. New York: New York Academy of Sciences.

Isaac, G.L. 1977a. Early stone tools – an adaptive threshold? In: G. de Sieveking, I.H. Longworth, K.E. Wilson (eds.), *Problems in economic and social archaeology*, pp. 39-47. London: Duckworth.

Isaac, G.L. 1977b. Squeezing blood from stones. In: R.V.S. Wright (ed.), *Stone Tools as Cultural Markers: Change, Evolution and Complexity*, pp. 5-12. Canberra: Australian Institute of Aboriginal Studies.

Isaac, G.L- 1977c. Obituary: David Leonard Clarke 1937-1976. *American Anthropologist* 79(3): 642-644.

Isaac, G.L. 1978c. The archaeological evidence for the activities of early African hominids. In: C.J. Jolly (ed.), *Early hominids of Africa*, pp. 219-254. London: Duckworth.

Isaac, G.L. 1980. Casting the net wide: a review of archaeological evidence for early hominid land-use and ecological relations. In L.K. Konigsson (ed.), *Current argument on Early Man*, pp. 226-251. London: Pergamon.

Isaac, G.L. 1981. Stone Age visiting cards: approaches to the study of early land-use patterns. In: I. Hodder, G.L. Isaac, N. Hammond (eds.), *Patterns of the Past*, pp. 131-155. Cambridge: Cambridge University Press

Isaac, B. (ed.) 1989. *The Archaeology of Human Origins. Papers by Glynn Isaac*. Cambridge: Cambridge University Press.

Isaac, G.L., J.W.K. Harris 1980. A method for determining the characteristics of artifacts between sites in the Upper Member of the Koobi Fora Formation, East Lake Turkana. In: R.E.F. Leakey, B.A. Ogot (eds.), *Proceedings of the 8th Panafrican Congress on Prehistory and Quaternary Studies*, pp. 19-22. Nairobi: International Louis Leakey Memorial Institute for African Prehistory.

Isaac, G.L., J.W.K. Harris, F. Marshall 1981. Small is informative: the application of the study of mini-sites and least effort criteria in the interpretation of the early Pleistocene archaeological record at Koobi Fora, Kenya. In: J.D. Clark, G.L. Isaac (eds.), *Las industrias mas antiguas*, pp. 101-119. Mexico: Xo Congreso Union Internacional de Ciencias Prehistoricas y Protohistoricas.

Iovita, R.P. 2008. *Ontogenetic scaling in stone tools and its application to European Middle Paleolithic systematics*. Unpublished Doctoral Dissertation, University of Pennsylvania.

Iovita, R.P. 2011. Shape variation in Aterian tanged tools and the origins of projectile technology: a morphometric perspective on stone tool function. *PLoS ONE* 6(12): e29029.

Iovita, R.P., S.P. McPherron 2011. The handaxe reloaded: A morphometric reassessment of Acheulian and Middle Paleolithic handaxes. *Journal of Human Evolution* 61(1): 61-74.

Iovita, R.P., H. Schönekeß, S. Gaudzinski-Windheuser, F. Jäger 2014. Projectile impact fractures and launching mechanisms: results of a controlled ballistic experiment using replica Levallois points. *Journal of Archaeological Science* 48: 73-83.

Iovita, R.P., I. Tuvi-Arad, M.-H. Moncel, J. Despriée, P. Voinchet, J.-J. Bahain 2017. High handaxe symmetry at the beginning of the European Acheulian: The data from la Noira (France) in context. *PLoS ONE* 12(5): e0177063.

Jackson, F.C. 1982. Epiphenomenal Qualia. *The Philosophical Quarterly* 32: 127-136.

James, W. 1914. *Pragmatism: A New Name for Some Old Ways of Thinking*. New York: Longmans.

Jaubert, J. 1993. Le gisement paléolithique moyen de Mauran (Haute-Garonne) : techno-économie des industries lithiques. *Bulletin de la Société préhistorique française* 90(5): 328-335.

Jaubert, J. 1999. *Chasseurs et artisans du Moustérien*. Paris: La Maison des Roches.

Jaubert, J., N. Fourment, P. Depaepe (eds.) 2014. *Transitions, ruptures et continuité en Préhistoire : Volume 2, Paléolithique et Mésolithique*. Paris: Société préhistorique française.

Jelinek, A. 1976. Form, function and style in lithic analysis. In: C.E. Cleland (ed.), *Cultural Change and Continuity: Essays in Honor of James Bennett Griffin*, pp. 147-173. New York: Academic Press.

Jelinek, A. 1991. Observations on reduction patterns and raw materials in some Middle Paleolithic industries in the Perigord. In: A. Montet-White, S. Holen (eds.), *Raw material economies among prehistoric hunter-gatherers*, pp. 7–32. Lawrence: University of Kansas.

Joachim, H.H. 1906. *The Nature of Truth*. Oxford: Clarendon Press.

Jochim, M.A. 1976. *Hunter-Gatherer Subsistence and Settlement: A Predictive Model*. New York: Academic Press.

Jochim, M.A. 1981. *Strategies for Survival. Cultural Behavior in an Ecological Context*. New York: Academic Press.

Jochim, M.A. 1983. Optimization models in context. In: J.A. Moore, A.S. Keene (eds.), *Archaeological Hammers and Theories*, pp. 157-172. New York: Academic Press.

Jochim, M.A. 1991. Archaeology as long-term ethnography. *American Anthropologist* 93: 308-321.

Jochim, M.A. 1998. *A Hunter-Gatherer Landscape. Southwest Germany in the Late Paleolithic and Mesolithic*. New York: Plenum Press.

Johnson, A.L. 2014. Exploring Adaptive Variation among Hunter-Gatherers with Binford's Frames of Reference. *Journal of Archaeological Research* 22(1): 1-42.

Johnson, C. 2014. 'French' cybernetics. *French Studies* LXIX(1): 60-78.

Johnson, M. 2010. *Archaeological Theory: An Introduction*. Second Edition. Chichester: Wiley-Blackwell.

Jonas, H. 2001. *The phenomenon of life*. Evanston: Northwestern University Press.

Jones, A.M. 2015. Meeting pasts halfway: a consideration of the ontology of material evidence in archaeology. In: R. Chapman, A. Wylie (eds.), *Material Evidence. Learning from archaeological practice*, pp. 324-338. London: Routledge.

Jones, S.C. 2007. The toba supervolcanic eruption: tephra-fall deposits in India and palaeoanthropological implications. In: M.D. Petraglia, B. Allchin (eds.), *The Evolution and History of Human Populations in South Asia*, pp. 173-200. New York: Springer.

Jones, S.C. 2010. Palaeoenvironmental response to the 74ka Toba ash-fall in Jurreru and Middle Son Valleys in southern and north-central India. *Quaternary Research* 73: 336-350.

Jones, S.C. 2012. Local- and regional-scale impacts of the ~74 ka Toba supervolcanic eruption on hominin populations and habitats in India. *Quaternary International* 258: 100-118.

Jones, S.C. 2016. Middle Stone Age reduction strategies at the desert's edge: A multi-site comparison across the Gebel Akhdar of northeast Libya. *Quaternary International* 408: 53-78.

Juarrero, A. 1999. *Dynamics in action: Intentional behavior as a complex system*. Cambridge (MA): The MIT Press.

Julien, M. 1992. Du fossile directeur à la chaîne opératoire. In: J. Garanger (ed.), *La Préhistoire dans le monde*, pp. 163-193. Paris: PUF.

Julien, M., J.-L. Rieu (eds.) 1999. *Occupations du Paléolithique supérieur dans le sud-est du Bassin parisien*. Paris: Éditions de la Maison des sciences de l'homme 78.

Julien, M., C. Karlin (eds.) 2014. *Un automne à Pincevent. Le campement magdalénien du niveau IV20*. Paris: Société préhistorique française.

Junghans, G. 2014 [1987]. *Gabriel de Mortillet 1821-1898: Eine Biographie*. Heidelberg: Propylaeum [Open Access: DOI: 10.11588/propylaeum.17.8].

Kahneman, D., A. Tversky 1996. On the Reality of Cognitive Illusions. *Psychological Review* 103: 582-591.

Karimi-Aghdam, S. 2016. Rethinking Vygotskian Cultural-Historical Theory in Light of Pepperian Root Metaphor Theory: Dynamic Interplay of Organicism and Contextualism. *Human Development* 59: 251-282.

Karlin, C. 1991. Connaissances et savoir-faire : comment analyser un processus technique en préhistoire, introduction. *Treballs d'Arqueologia* 1: 99-124.

Karlin, C., N. Pigeot 1989. Chasseurs-cueilleurs magdaléniens : techniques de taille et apprentisage de la taille du silex. *Le Courier du CNRS* 73: 10-11.

Karlin, C., M. Julien 1994. Prehistoric Technology: A Cognitive Science? In: C. Renfrew, E.B.W. Zubrow (eds.), *The Ancient Mind: Elements of a Cognitive Archaeology*, pp. 152-164. Cambridge: Cambridge University Press.

Karlin, C., S. Ploux, P. Bodu, N. Pigeot 1993. Some socio-economic aspects of the knapping process among groups of hunter-gatherers in the Paris Basin area. In: A. Berthelet, J. Chavaillon (eds.), *The use of tools by human and non-human primates*, pp. 318-337. Gloucestershire: Clarendon Press.

Kauffman, S. 1993. *The Origins of Order: Self-Organization and Selection in Evolution*. New York: Oxford University Press.

Kavanagh, H. 2007. The Repertoire of Archaeological Images. In: J. Elkins (ed.), *Visual Practices across the University*, pp. 141-151. München: Wilhelm-Fink Verlag.

Kellert, S.H., H.E. Longino, C.K. Waters (eds.) 2006a. *Scientific Pluralism*. Minneapolis: University of Minnesota Press.

Kellert, S.H., H.E. Longino, C.K. Waters 2006b. Introduction: The Pluralist Stance. In: S.H. Kellert, H.E. Longino, C.K. Waters (eds.), *Scientific Pluralism*, pp. vii-xxix. Minneapolis: University of Minnesota Press.

Kelly, R.L. 1983. Hunter-Gatherer Mobility Strategies. *Journal of Anthropological Research* 39: 277-306.

Kelly, R.L. 1988. The three sides of a biface. *American Antiquity* 53: 717-734.

Kelly, R.L. 1992. Mobility/Sedentism: Concepts, Archaeological Measures, and Effects. *Annual Review of Anthropology* 211(1): 43-66.

Kelly, R.L. 1995. *The Foraging Spectrum: Diversity in Hunter-Gatherer Lifeways*. New York: Percheron Press.

[Kelly, R.L. 2013. *The Lifeways of Hunter-Gatherers: The Foraging Spectrum*. Cambridge: Cambridge University Press.]

Kelly, R.L. 2014. Future Directions in Hunter-Gatherer Research: Technology. In: V. Cummings, P. Jordan, M. Zvelebil (eds.), *The Oxford Handbook of the Archaeology and Anthropology of Hunter-Gatherers*, pp. 1110-1126. Oxford: Oxford University Press.

Kelly, R.L. 2016. *The Fifth Beginning. What Six Million Years of Human History Can Tell Us About Our Future*. Oakland: University of California Press.

Kerry, K.W., D.O. Henry 2000. Conceptual Domains, Competence, and *Chaîne Opératoire* in the Levantine Mousterian. In: L.E. Stager, J.A. Greene, M.D. Coogan (eds.), *The Archaeology of Jordan and Beyond. Essays in Honor of James A. Sauer*, pp. 238-254. Winona Lake (IN): Eisenbrauns.

Kim, J. 1984. Concepts of Supervenience. *Philosophy and Phenomenological Research* 45(2): 153-176.

Kim, J. 1992. Multiple Realization and the Metaphysics of Reduction. *Philosophy and Phenomenological Research* 52(1): 1-26.

Kim, J. (ed.) 2002. *Supervenience*. London: Routledge.

Kitcher, P. 1981. Explanatory Unification. *Philosophy of Science* 48(4): 507-531.

Kitcher, P. 1990. The Division of Cognitive Labor. *The Journal of Philosophy* 87(1): 5-22.

Kitcher, P. 1993. *The Advancement of Science: Science Without Legend, Objectivity Without Illusions*. Oxford: Oxford University Press.

Kitcher, P. 2001. *Science, Truth, and Democracy*. Oxford: Oxford University Press.

Klages, L. 1934. *Vom Wesen des Rhythmus*. Kampen auf Sylt: Kampmann.

Klaric, L. 2003. *L'unité technique des industries à burin du Raysse dans leur contexte diachronique. Réflexions sur la diversité culturelle au Gravettien à partir des données de La Picardie, d'Arcy-sur-Cure, de Brassempouy et du Cirque de la Patrie*. Unpublished Doctoral Dissertation, Université de Paris I-Sorbonne.

Klaric, L. 2007. Regional Groups in the European Middle Gravettian: a reconsideration of the Rayssian technology. *Antiquity* 81: 176-190.

Klaric, L. 2013. Faciès lithiques et chronologie du Gravettien du sud du Bassin parisien et de sa marge sud-occidentale. In: P. Bodu, L. Chehmana, L. Klaric, L. Mevel, S. Soriano (eds.), *Le Paléolithique supérieur ancien de l'Europe du Nord-Ouest*, pp. 61-87. Paris: Mémoire de la Société préhistorique française 56.

Klein, R.G. 2009. *The Human Career. Human Biological and Cultural Origins*. Third Edition. Chicago: University of Chicago Press.

Klein, R.G. 2013. F. Clark Howell 1925–2007. *Biographical Memoirs of the National Academy of Sciences*, United States of America.

Kliemt, H. 2013. Homo economicus. In: B. Kaldis (ed.), *Encyclopedia of Philosophy and the Social Sciences*, pp. 430-431. Los Angeles: Sage Publications.

Knüsel, C.J. 1992. Variable views of Middle Palaeolithic adaptation, behaviour and variability. *Antiquity* 66: 981-986.

Koehler, H. 2011. *Comportements et identité techniques au Paléolithiques moyen dans le Bassin parisien : une question d'échelle d'analyse ?* Paris: Presses Universitaires de Paris Ouest.

Kohn, M. 1999. *As We Know it: Coming to Terms with an Evolved Mind*. London: Granta Books.

Kohn, M., S. Mithen 1998. Handaxes: products of sexual selection? *Antiquity* 73: 518-526.

Krajewski, W. 1997. Energetic, Informational, and Triggering Causes. *Erkenntnis* 47: 193-202.

Krausz, M. 1993. *Rightness and Reasons: Interpretation in Cultural Practices*. Ithaca: Cornell University Press.

Krausz, M. 2007. *Interpretation and Transformation. Explorations in Art and the Self*. Amsterdam: Rodopi Editions.

Krebs, J., N. Davies 1978. *Behavioral Ecology: An Evolutionary Approach*. Oxford: Blackwell.

Kroll, E.M. 1994. Behavioral implications of Plio-Pleistocene archaeological site structure. *Journal of Human Evolution* 27(1-3): 107-138.

Kroll, E.M., G.L. Isaac 1984. Configurations of artifacts and bones at Early Pleistocene sites in East Africa. In: H.J. Hietala (ed.), *Intrasite spatial analysis in archaeology*, pp. 4-30. Cambridge: Cambridge University Press.

Kuhn, S.L. 1990. A Geometric Index of Reduction for Unifacial Stone Tools. *Journal of Archaeological Science* 17: 583-593.

Kuhn, S.L. 1992. On planning and curated technologies in the Middle Paleolithic. *Journal of Anthropological Research* 48: 185-214.

Kuhn, S.L. 1993. Mousterian Technology as Adaptive Response: A Case Study. *Archaeological Papers of the American Anthropological Association* 4(1): 25-31.

Kuhn, S.L. 1994. Formal Approach to the Design and Assembly of Mobile Toolkits. *American Antiquity* 59(3): 426-442.

Kuhn, S.L. [2014] 1995. *Mousterian Lithic Technology: An Ecological Perspective*. Princeton: Princeton University Press.

Kuhn, S.L. 2004a. Evolutionary perspectives on technology and technological change. *World Archaeology* 36(4): 561-570.

Kuhn, S.L. 2004b. Upper Paleolithic raw material economies at Uçağızlı cave, Turkey. *Journal of Anthropological Archaeology* 23: 431-448.

Kuhn, S.L. 2011. Neanderthal Technoeconomics: An Assessment and Suggestions for Future Developments. In: N.J. Conard, J. Richter (eds.), *Neanderthal Lifeways, Subsistence and Technology. One Hundred Fifty Years of Neanderthal Study*, pp. 99-110. Dordrecht: Springer.

Kuhn, S.L., A.E. Clark 2014. Stone Tool Technology. In: V. Cummings, P. Jordan, M. Zvelebil (eds.), *The Oxford Handbook of the Archaeology and Anthropology of Hunter-Gatherers*, pp. 607-624. Oxford: Oxford University Press.

Kuhn, S.L., A.E. Clark 2015. Artifact densities and assemblage formation: Evidence from Tabun Cave. *Journal of Anthropological Archaeology* 38: 8-16.

Kuhn, S.L., D.S. Miller 2015. Artifacts as Patches: The Marginal Value Theorem and Stone Tool Life Histories. In: N. Goodale, W. Andrefsky Jr. (eds.), *Lithic Technological Systems and Evolutionary Theory*, pp. 172-197. Cambridge: Cambridge University Press.

Kuhn, S.L., D.A. Raichlen, A.E. Clark 2016. What Moves Us? How Mobility and Movement Are at the Center of Human Evolution. *Evolutionary Anthropology* 25: 86-97.

Kuhn, T.S. 1977. Objectivity, value judgment, and theory choice. In: A. Bird, J. Ladyman (eds.), *Arguing About Science*, pp. 74-86. London: Routledge.

Kuhn, T.S. 1996 [1972]. *The Structure of Scientific Revolutions*. Third Edition. Chicago: University of Chicago Press.

Kukla, A. 1996. Does every theory have empirically equivalent rivals? *Erkenntnis* 44: 137-166.

Kulpa, Z. 1994. Diagrammatic Representation and Reasoning. *Machine GRAPHICS & VISION* 3(1/2): 77-103.

Lakatos, I. 1970. *Falsification and the Methodology of Scientific Research Programmes*. In: I. Lakatos, A. Musgrave (eds.), *Criticism and the Growth of Knowledge*, pp. 91-196. Cambridge: Cambridge University Press.

Lakatos, I. 1977. *The Methodology of Scientific Research Programmes*: *Philosophical Papers Volume 1*. Cambridge: Cambridge University Press.

Lakoff, G., M. Johnson 1980a. *Metaphors We Live By*. Chicago: University of Chicago Press.

Lakoff, G., M. Johnson 1980b. Conceptual Metaphor in Everyday Language. *The Journal of Philosophy* 77(8): 453-486.

Lake, M.W. 2014. Trends in Archaeological Simulation. *Journal of Archaeological Method and Theory* 21: 258-287.

Langlais, M.C., C. Clarkson, S. Ulm 2008. Behavioural Complexity in Eurasian Neanderthal Populations: a Chronological Examination of the Archaeological Evidence. *Cambridge Archaeological Journal* 18(3): 289-307.

Langlais, M. 2007. *Dynamiques culturelles des sociétés magdaléniennes dans leurs cadres environnementaux. Enquête sur 7000 ans d'évolution de leurs équipements lithiques entre Rhône et Èbre*. Unpublished Doctoral Dissertation, Université de Toulouse II-le Mirail/ University of Barcelona.

Langlais, M. 2010. *Les Sociétés Magdaléniennes de L'Isthme Pyrénéen*. Paris: CTHS.

Langlais, M., S. Costamagno, V. Laroulandie, J.-M. Pétillon, E. Discamps, J.-B. Mallye, D. Cochard, D. Kuntz 2012. The evolution of Magdalenian societies in South-West France between 18,000 and 14,000 calBP: Changing environments, changing tool kits. *Quaternary International* 272-273: 138-149.

Langlais, M., A. Sécher, S. Caux, V. Delvigne, L. Gourc, C. Normand, M. Sanchez de la Torre 2016. Lithic tool kits: A Metronome of the evolution of the Magdalenian in southwest France (19,000-14,000 cal. BP). *Quaternary International* 414: 92-107.

Laplace, G. 1966a. *Recherches sur l'origine et l'évolution des complexes leptolithiques*. Paris: École française de Rome (Mélanges d'archéologie et d'histoire).

Laplace, G. 1966b. Pourquoi une typologie analytique? *L'Anthropologie* 70(1-2): 193-201.

Laplace, G. 1968. Recherche de typologie analytique. *Origini* II: 7-64.

Laplace, G. 1972. Liste typologique. *Dialektikê* (Cahiers de typologie analytique, Centre de Palethnologie stratigraphique Eruri, Pau): 9-27.

Latour, B. 1986. Visualization and cognition: Thinking with eyes and hands. *Knowledge in Society* 6: 1- 40.

Latour, B. 1987. *Science in Action: How to Follow Scientists and Engineers through Society*. Cambridge (MA): Harvard University Press.

Latour, B. 1991. *Nous n'avons jamais été modernes: Essais d'anthropologie symmétrique*. Paris: La Découverte.

[Latour, B. 1992. *We Have Never Been Modern*. Translated by Catherine Porter. Cambridge (Massachusetts): Harvard University Press.]

Latour, B. 1994. On technical mediation - philosophy, sociology, genealogy. *Common Knowledge* 3(2): 29-64.

Latour, B. 2011. Reflections on Etienne Souriau's Les différents modes d'existence. In: L.R. Bryant, N. Srnicek, G. Harman (eds.), *The Speculative Turn: Continental Materialism and Realism*, pp. 304-333. Victoria: Re.Press.

Latour, B. 2012. *Enquête sur les modes d'existence: Une anthropologie des Modernes*. Paris: La Découverte.

[Latour, B. 2013. *An Inquiry into Modes of Existence. An Anthropology of the Moderns*. Translated by Catherine Porter. Cambridge (Massachusetts): Harvard University Press.]

Latour, B., P. Lemmonier (eds.) 1994. *De la préhistoire aux missiles balistiques, l'intelligence des techniques*. Paris: La Découverte.

Laudan, L. 1977. *Progress and Its Problems: Toward a Theory of Scientific Growth*. Berkeley: University of California Press.

Laughlin, R. 2005. *A Different Universe: Reinventing Physics from the Bottom Down*. New York: Basic Books.

Laurent, P. 1985. Le dessin des objets préhistoriques: une introduction. *Revue archéologique du Centre de la France* 24(1): 83-96.

Law, A. 2015. *Social Theory For Today. Making Sense of Social Worlds*. Los Angeles: Sage.

Lazuén, T., A. Delagnes 2014. Lithic tool management in the Early Middle Paleolithic: an integrated techno-functional approach applied to Le Pucheuil-type production (Le Pucheuil, northwestern France). *Journal of Archaeological Science* 52: 337-353.

Leakey, M.D. 1971. *Olduvai Gorge, Volume 3: Excavations in Beds I and II, 1960-1963*. Cambridge: Cambridge University Press.

Leakey, M.D., D.A. Roe (eds.) 1994. *Olduvai Gorge, vol. 5. Excavations in Beds III, IV, and the Masek Beds 1968-1971*. Cambridge: Cambridge University Press.

Le Brun-Ricalens, F. 1993. Réflexions préliminaires sur le comportement litho-technologique et l'occupation du territoire du pays des Serres à l'Aurignacien. Le gisement de "Toulousète" à Beauville (Lot et Garonne). Une occupation moustérienne et aurignacienne de plein air. *Paléo* 5: 127-153.

Le Brun-Ricalens, F. 2005. Reconnaissance d'un "concept technoculturel" de l'Aurignacien ancien ? Modalités, unités et variabilités des productions lamellaires du site d'Hui (Beauville, Lot-et-Garonne, France) : significations et implications. In: F. Le Brun-Ricalens in collaboration with J.-G. Bordes and F. Bon (eds.), *Productions lamellaires attribuées à l'Aurignacien : chaîne opératoires et perspectives technoculturelles*, pp. 157-190. Luxembourg: ArchéoLogiques 1 (Publications du Musée National d'Histoire et d'Art).

Le Brun-Ricalens, F., L. Brou 2003. Burins carénés – nucléus à lamelles : identification d'une chaîne particulière à Thèmes (Yonne) et implications. *Bulletin de la Société préhistorique française* 100(1): 67-83.

Le Brun-Ricalens, F., L. Brou, D. Pesesse 2006. Fiches descriptives de nucléus-outil carénés : I – burins et grattoirs épais. In: M. de Araujo Igreja, J.-P. Bracco, F. Le Brun-Ricalens (eds.), *Burins préhistoriques : formes, fonctionnements, fonctions*, pp. 361-376. ArchéoLogiques 2. Luxembourg: Publications du Musée National d'Histoire et d'Art.

Leclair Jr., E., H.K. Schneider (eds.) 1968. *Economic anthropology: readings in theory and analysis*. New York: Holt, Rinehart and Winston Inc.

Lee, O. 1944. Value and the Situation. *The Journal of Philosophy* 41(13): 337-360.

Lee, R.B., I. deVore (eds.) 1968. *Man the Hunter*. Chicago: Aldine.

Lefebvre, H. 1968. *Dialectical Materialism*. London: Jonathan Cape.

Lefebvre, H. 1991. *Critique of Everyday Life, Vol. I*. London: Verso.

Lefebvre, H. 2004. *Rhythmanalysis: Space, Time, and Everyday Life*. New York: Continuum.

Lemonnier, P. 1976. La déscription des chaînes opératoires. *Techniques & Culture* 1: 100-151.

Lemonnier, P. 1983. L'étude des systèmes techniques, une urgence en technologie culturelle. *Techniques & Culture* 1: 11-34.

Lemonnier, P. 1986. Study of Material Culture Today: Toward an Anthropology of Technical Systems. *Journal of Anthropological Archaeology* 5: 147-186.

Lemonnier, P. 2012. *Mundane Objects. Materiality and Non-verbal Communication*. Walnut Creek: Left Coast Press.

Lenoir, M. 2008. Typologie et technologie: alliées ou opposées? In: T. Aubry, F. Almeida, A.C. Araujo, M. Tiffagom (eds.), *Space and Time: Which Diachronies, which Synchronies, which Scales?*, pp.115-122. Oxford: Archaeopress.

Lepot, M. 1992/1993. *Approche techno-fonctionnelle de l'outillage lithique moustérien : essai de classification des parties actives en termes d'efficacité technique. Application à la couche M2e sagittale du Grand Abri de La Ferrassie (fouille Henri Delporte)*. Unpublished Mémoire de la Maitrise, Université de Paris X – Nanterre.

Leroi-Gourhan, A. 1936a. *La Civilisation du renne*. Paris: Gallimard.

Leroi-Gourhan, A. 1936b. Formes élémentaire de l'activité humaine. In: P. Rivet (ed.), *Encyclopédie Française, Tome VII: L'espèce humaine*, pp. 7'10-3 - 7'12-4. Paris: Société de Gestion de l'Encyclopédie Française.

Leroi-Gourhan, A. [1971] 1943. *Évolution et techniques : L'homme et la matière*. Paris: Éditions Albin Michel.

Leroi-Gourhan, A. [1973] 1945. *Évolution et techniques : Milieu et technique*. Paris: Éditions Albin Michel.

Leroi-Gourhan, A. 1949. Note sur les rapports de la technologie et de la sociologie. *L'Année sociologique* III: 766-772.

Leroi-Gourhan, A. 1964. *Le Geste et la Parole, tome 1 : Technique et langage*. Paris: Éditions Albin Michel.

Leroi-Gourhan, A. 1965. *Le Geste et la Parole, tome 2 : La mémoire et les rythmes*. Paris: Éditions Albin Michel.

[Leroi-Gourhan, A. 1993. *Gesture and Speech*. Translated from French by Anna Bostock Berger and introduced by Randall White. Cambridge (MA): MIT Press.]

Leroi-Gourhan, A. 1968. Le petit racloir châtelpérronien. In: Centre National de la Recherche Scientifique (ed.), *La Préhistoire : Problèmes et Tendances*, pp. 275-282. Paris: Éditions du CRNS.

Leroi-Gourhan, A. 1971. Reconstituer la vie. In: H. Saint-Blanquat (ed.), *La vie préhistorique*, pp. 57-68. Paris: Sciences et Avenir.

Leroi-Gourhan, A. 1972. Synthèse et hypothèses. In: A. Leroi-Gourhan, M. Brézillon (eds.), *Fouilles de Pincevent. Essai d'analyse ethnographique d'un habitat magdalénien (la section 36)*, pp. 257-261. Paris: CNRS Éditions.

Leroi-Gourhan, A. 1982. *Les Racines du monde. Entretiens avec Claude-Henri Rocquet*. Paris: Belfond.

Leroi-Gourhan, A. (ed.) 1983a. *Le fil du temps : ethnologie et préhistoire, 1935-1970*. Paris: Fayard.

Leroi-Gourhan, A. 1983b. Reconstituer la vie. In : A. Leroi-Gourhan (ed.), Le fil du temps : ethnologie et préhistoire, 1935-1970, pp. 245-255. Paris: Fayard.

Leroi-Gourhan, A. 1984. *Pincevent. Campement magdalénien de chasseurs de rennes*. Paris: Ministère de la Culture.

Leroi-Gourhan, A., M. Brézillon 1972. *Fouilles de Pincevent : essai d'analyse ethnographique d'un habitat magdalénien (la section 36)*. Paris: Éditions de CNRS.

Leroi-Gourhan, A., M. Brézillon, B. Schmider 1976. Les civilisations du paléolithique supérieur dans le centre et le sud-est du Bassin parisien. In: H. de Lumley (ed.), *La Préhistoire française, volume 1*, pp. 1321-1338. Paris: Éditions de CRNS.

Leroyer, M. 2016. *Palethnologie acheuléenne : de la technologie bifaciale à l'organisation de la subsistance collective. Étude du site de Boxgrove – Eartham Pit (West Sussex, Angleterre) et deux sites du cours moyen de la Seine*. Unpublished Doctoral Dissertation, Université de Paris I-Sorbonne.

Lestrel, P. 1997. *Fourier Descriptors and their Applications in Biology*. New York: Cambridge University Press.

Lestrel, P. 2000. *Morphometrics for the Life Sciences*. Singapore: World Scientific.

Levinson, J. 1980. What a Musical Work Is. *The Journal of Philosophy* 77(1): 5-28.

Lévi-Strauss, C. 1969 [1966]. *The Savage Mind*. Chicago: University of Chicago Press.

Levit, G.S., L. Olsson 2006. "Evolution on Rails": Mechanisms and Levels of Orthogenesis. *Annals of the History and Philosophy of Biology* 11: 99-138.

Lin, S.C., Z. Rezek, D. Braun, H.L. Dibble 2013. On the utility and economization of unretouched flakes: the effects of exterior platform angle and platform depth. *American Antiquity* 78(4): 724-745.

Lin, S.C., Z. Rezek, H.L. Dibble 2017. Experimental Design and Experimental Inference in Stone Artifact Archaeology. *Journal of Archaeological Method and Theory*. DOI=https://doi.org/10.1007/s10816-017-9351-1.

Lipo, C.P., M.J. O'Brien, M. Collard (eds.) 2005. *Mapping Our Ancestors: Phylogenetic Approaches in Anthropology and Prehistory*. New York: Routledge.

Lipton, P. 2001. *Inference to the Best Explanation*. London: Routledge.

Lippé, R. 2007. *Histoire critique de la transition entre paléolithiques moyen et supérieur en archéologie préhistorique française, des origines à la seconde moitié du XXe siècle*. Unpublished M.A. Dissertation, Université de Montréal.

Lippé, R. 2010. Pierres à convictions: Georges Laplace et la polymorphie des complexes leptolithiques. In: S. Archambault de Beaune (ed.), *Ecrire le passé : la fabrique de la préhistoire et de l'histoire à travers les siècles*, pp. 309-319, Paris: CRNS Éditions.

Lippé R. 2012. *Nature, culture et progrès. Histoire comparative du concept de transition entre paléolithiques moyen et supérieur en archéologie préhistorique*. Unpublished Doctoral Dissertation, Universités de Bordeaux et de Montréal.

Livingstone, D.N. 2012. Changing Climate, Human Evolution, and the Revival of Environmental Determinism. *Bulletin of the History of Medicine* 86(4): 564-595.

Locht, J.-L. 2004. *Le Gisement paléolithique moyen de Beauvais (Oise). Contribution à la connaissance des modalités de subsistence des chasseurs de Renne du Pléniglaciaire inférieur du Weichsélien*. Unpublished Doctoral Dissertation, Université de Lille I.

Loiseau, J.-P. 2014. *François Bordes (1919-1981) et la construction de la Préhistoire dans la seconde moitié du XX^{e} siècle*. Unpublished Doctoral Dissertation, Université de Bordeaux.

Long, M. 1990. *Pepper's selectivism as a basis for the reconceptualization of a theory of human development*. Unpublished Doctoral Dissertation, Arizona State Univerity.

Longino, H.E. 1990. *Science as Social Knowledge: Values and Objectivity in Scientific Inquiry*. Princeton: Princeton University Press.

Lopes, D. 2009. Drawing in a Social Science: Lithic Illustration. *Perspectives on Science* 17(1): 5-25.

Lourdeau, A. 2010. *Le technocomplexe Itaparica : définition techno-fonctionnelle des industries à pièces façonnées unifacialement à une face plane dans le centre et le nord-est du Brésil pendant la transition Pléistocène-Holocène et l'Holocène ancien*. Unpublished Doctoral Dissertation, Université de Paris X-Nanterre.

Lucas, G. 2012. *Understanding the Archaeologicla Record*. Cambridge: Cambridge University Press.

Lucas, G. 2015. Evidence of *what*? On the possibilities of archaeological interpretation. In: R. Chapman, A. Wylie (eds.), *Material Evidence. Learning from archaeological practice*, pp. 311-323. London: Routledge.

Luhmann, N. 1984. *Soziale Systeme. Grundriss einer allgemeinen Theorie*. Frankfurt am Main: Suhrkamp.

Luhmann, N. 1990. *Essays on Self-Reference*. Columbia: Columbia University Press.

Lycett, S.J. 2007a. Is the Soanian techno-complex a Mode 1 or Mode 3 phenomenon? A morphometric assessment. *Journal of Archaeological Science* 34(9): 1434-1440.

Lycett, S.J 2007b. Why is there a lack of Mode 3 Levallois technologies in East Asia? A phylogenetic test of the Movius-Schick hypothesis. *Journal of Anthropological Archaeology* 26: 541-575.

Lycett, S.J. 2008. Acheulean variation and selection: does handaxe symmetry fit neutral expectations? *Journal of Archaeological Science* 35: 2640-2648.

Lycett, S.J. 2009a. Understanding Ancient Hominin Dispersals Using Artefactual Data: A Phylogeographic Analysis of Acheulean Handaxes. *PLoS ONE* 4(10): e7404.

Lycett, S.J. 2009b. Quantifying Transitions: Morphometric Approaches to Palaeolithic Variability and Technological Change. In: M. Champs, P. Chauhan (eds.), *Sourcebook of Paleolithic Transitions. Methods, Theories, and Interpretations*, pp. 79-92. New York: Springer.

Lycett, S.J 2009c. Are Victoria West cores 'proto-Levallois'? A phylogenetic assessment. *Journal of Human Evolution* 56: 175-191.

Lycett, S.J. 2010. Quantifying Transitions: Morphometric Approaches to Palaeolithic Variability and Technological Change. In: S.J. Lycett, P.R. Chauhan (eds.), *New Perspectives on Old Stones. Analytical Approaches to Paleolithic Technologies*, pp. 79-92. New York: Springer.

Lycett, S.J. 2016. The Importance of a "Quantitative Genetic" Approach to the Evolution of Artifact Morphological Traits. In: L. Mendoza Straffon (ed.), *Cultural Phylogenetics. Concepts and Applications in Archaeology*, pp. 73-93. Cham: Springer.

Lycett, S.J., J.A.J. Gowlett 2008. On questions surrounding the Acheulean 'tradition'. *World Archaeology* 40(3): 295-315.

Lycett, S.J., P.R. Chauhan (eds.) 2010a. *New Perspectives on Old Stones. Analytical Approaches to Paleolithic Technologies*. New York: Springer.

Lycett, S.J., P.R. Chauhan 2010b. Analytical Approaches to Palaeolithic Technologies: An Introduction. In: S.J. Lycett, P.R. Chauhan (eds.), *New Perspectives on Old Stones. Analytical Approaches to Paleolithic Technologies*, pp. 23-41. New York: Springer.

Lycett, S.J., C.J. Norton 2010. A demographic model for Palaeolithic technological evolution: The case of East Asia and the Movius Line. *Quaternary International* 211(1–2): 55-65.

Lycett, S.J., N. von Cramon-Taubadel 2013. A 3D morphometric analysis of surface geometry in Levallois cores: patterns of stability and variability across regions and their implications. *Journal of Archaeological Science* 40(3): 1508-1517.

Lycett, S.J., N. von Cramon-Taubadel 2015. Toward a "Quantitative Genetic" Approach to Lithic Variation. *Journal of Archaeological Method and Theory* 22: 646-675.

Lycett, S.J., S.J. Shennan 2018. David Clarke's *Analytical* Archaeology at 50. *World Archaeology*: DOI: 10.1080/00438243.2018.1470561.

Lycett S.J., N. von Cramon-Taubadel, R.A. Foley 2006. A crossbeam co-ordinate caliper for the morphometric analysis of lithic nuclei: a description, test and empirical examples of application. *Journal of Archaeological Science* 33: 847-861.

Lycett, S.J., M. Collard, W.C. McGrew 2007. Phylogenetic analyses of behavior support existence of culture among wild chimpanzees. *PNAS* 104: 17588-17593.

Lyman, R.L. 2015. Graphing Evolutionary Pattern in Stone Tools to Reveal Evolutionary Process. In: N. Goodale, W. Andrefsky Jr. (eds.), *Lithic Technological Systems and Evolutionary Theory*, pp. 29-47. Cambridge: Cambridge University Press.

Lyman, R.L., M.J. O'Brien 2000. *Applying Evolutionary Archaeology. A Systematic Approach*. New York: Kluwer Academic/ Plenum Press.

Lynch, M. 1998. *Truth in Context. An Essay on Objectivity and Pluralism*. Cambridge (MA): MIT Press.

Lynch, M.E., S. Woolgar 1988. Sociological orientations to representational practice in science. *Human Studies* 11(2/3): 99-116.

Lynch, M.E., S. Woolgar (eds.) 1990. *Representation in Scientific Practice*. Cambridge (MA): The MIT Press.

Lyre, H. 2011. Is structural underdetermination possible?. *Synthese* 180: 235-247.

Machin, A.J. 2009. The role of the individual agent in Acheulean biface variability. A multi-factorial model. *Journal of Social Archaeology* 9(1): 35-58.

Machin, A.J., S.J. Mithen 2004. Comment on McNabb, J., F. Binyon, L. Hazelwood, Large cutting tools from the South African Acheulean and the question of social traditions. *Current Anthropology* 45(5): 653-668 [668-669].

Machin, A.J., R.T. Hosfield, S.J. Mithen 2005. Testing the functional utility of handaxe symmetry: fallow deer butchery with replica handaxes. *Lithics: The Journal of the Lithic Studies Society* 26: 23-37.

Machin, A.J., R.T. Hosfield, S.J. Mithen 2007. Why are some handaxes symmetrical? Testing the influence of handaxe morphology on butchery effectiveness. *Journal of Archaeological Science* 34: 883-893.

Magnani, M. 2014. Three-Dimensional Alternatives to Lithic Illustration. *Advances in Archaeological Practice* 2(4): 285-297.

Magnani, M., Z. Rezek, S.C. Lin, A. Chan, H.L. Dibble 2014. Flake variation in relation to the application of force. *Journal of Archaeological Science* 46: 37-49.

Malafouris, L. 2010. Metaplasticity and the human becoming: principles of neuroarchaeology. *Journal of Anthropological Sciences* 88: 49-72.

Mannheim, K. 1936 [1929]. *Ideology and Utopia. An Introduction to the Sociology of Knowledge*. Translated from the German by L. Wirth, E. Shils. London: Routledge & Kegan Paul.

Marian, D. 2016. The Correspondence Theory of Truth. In: E.N. Zalta (ed.), *The Stanford Encyclopedia of Philosophy*: URL = https://plato.stanford.edu/archives/fall2016/entries/truth-correspondence/ [last accessed 10.05.2018].

Martin, J.L. 2003. What Is Field Theory? *American Journal of Sociology* 109(1): 1-49.

Martingell, H., Saville, A. 1988. *The Illustration of Lithic Artefacts: A Guide to Drawing Stone Tools For Specialist Reports*. Northampton: The Lithic Studies Society.

Mathewson, K. 2016. Obituary: Karl Wilhelm Butzer, 1934-2016. *Journal of Historical Geography* 55: 93-98.

Mattice, S.A. 2014. *Metaphor and Metaphilosophy. Philosophy as Combat, Play, and Aesthetic Experience*. Lanham: Lexington Books.

Maturana, H.R., F.J. Varela 1973. *Autopoiesis and Cognition: The Realization of the Living*. Dordecht: D. Reidel Publishing.

Maturana, H.R., F.J. Varela 1987. *The tree of knowledge: The biological roots of human understanding*. Boston: Shambhala Publications.

Marchand, G. 1999a. *La Néolithisation de l'ouest de la France: caractérisation des industries lithiques*. BAR International Series 784. Oxford: Archaeopress.

Marchand, G. 1999b. Éléments pour la définition du Retzien. In: P. Bintz P., A. Thévenin (eds.), *L'Europe des derniers chasseurs : Épipaléolithique et Mésolithique*, pp. 213-224. Paris: C.T.H.S.

Marchand, G. 2014. *Préhistoire Atlantique. Fonctionnement et évolution des sociétés du Paléolithique au Néolithique*. Paris: Éditions errance.

Marchand, G. 2015. Living on the Edge of the World: The Mesolithic Communities of the Atlantic Coast in France and Portugal. In: N. Bicho, C. Detry, T.D. Price, E. Cunha (eds.), *Muge 150th: The 150th Anniversary of the Discovery of Mesolithic Shellmiddens – Volume 1*, pp. 274-285. Newcastle upon Tyne: Cambridge Scholars Publishing.

Marchand, G. 2017. Préface. In: L. Mevel, *Sociétés en Mouvement. Évolution des Sociétés Magdaléniennes et Aziliennes des Alpes du Nord Françaises*, pp. 9-10. Paris: CTHS.

Marchand, G., A. Tresset (eds.) 2005. *Unité et diversité des processus de néolithisation sur la façade atlantique de l'Europe (6e-4e millénaires avant J.-C.).* Paris: Société préhistorique française.

Marean, C.W. 2007. Heading north: an Africanist perspective on the replacement of Neanderthals by modern humans. In: P. Mellars, K. Boyle, O. Bar-Yosef (eds.), *Rethinking the human revolution*, pp. 367-382. Cambridge: McDonald Institute for Archaeological Research.

Marean, C.W. 2010. When the Sea Saved Humanity. *Scientific American* 303(2): 54-61.

Marean, C.W. 2011. Coastal South Africa and the Coevolution of the Modern Human Lineage and the Coastal Adaptation. In: N.F. Bicho, J.A. Haws, L.G. Davies (eds.*), Trekking the Shore. Changing Coastlines and the Antiquity of Coastal Settlement*, pp. 421-440. New York: Springer.

Marks, A.E. 1976. Site D5: a Geometric Kebaran "A" occupation in the Nahal Zin. In: A.E. Marks (ed.), *Prehistory and Paleoenvironments in the Central Negev, Israel*, pp. 293-326. Dallas: Southern Methodist University.

Marks, A.E. 1988. The Curation of Stone Tools During the Upper Pleistocene: A View From the Central Negev, Israel. In: H.L. Dibble, A. Montet-White (eds.), *Upper Pleistocene Prehistory of Western Eurasia*, pp. 275-286. Pennsylvania: University of Pennsylvania Press.

Marks, A.E. 2003. Reflections on Levantine Upper Paleolithic Studies: Past and Present. In: A.N. Goring-Morris, A. Belfer-Cohen (eds.), *More than Meets the Eye. Studies on Upper Paleolithic Diversity in the Near East*, pp. 249-264. Oxford: Oxbow Books.

Marks, A.E., H.J. Hietala, J.K. Williams 2001. Tool standardization in the Middle and Upper Palaeolithic: A closer look. *Cambridge Archaeological Journal* 11(1): 17-44.

Martinelli, B. 1988. Après André Leroi-Gourhan: les chemins de la technologie. In: *André Leroi-Gourhan ou les voies de l'homme,* pp. 61-89. Paris: Albin-Michel.

Marwick, B. 2008a. Beyond typologies: The reduction thesis and its implications for lithic assemblages in Southeast Asia. *Bulletin of the Indo-Pacific Prehistory Association* 28: 108-116.

Marwick, B. 2008b. What attributes are important for the measurement of assemblage reduction intensity? Results from an experimental stone artefact assemblage with relevance to the Hoabinhian of mainland Southeast Asia. *Journal of Archaeological Science 35*(5): 1189-1200.

Marwick, B. 2017. Computational Reproducibility in Archaeological Research: Basic Principles and a Case Study of Their Implementation. *Journal of Archaeological Method and Theory* 24(2): 424-450.

Mauss, M. 1935. Les techniques du corps. *Journal de psychologie normale et pathologique* 32: 271-293.

Mauss, M. 1947. *Manuel d'ethnographie*. Paris: Payot.

Mauss, M. 2006 [1929/1930]. Civilisations, their elements and forms. In: N. Schlanger (ed.), *Techniques, Technologies and Civilisation*, pp. 57-74. Oxford and New York: Berghahn.

Mayhew, S. 2015. Equifinality. In: S. Mayhew (ed.), *A Dictionary of Geography*. Oxford: Oxford University Press [retrieved on the 22.07.2018].

Maynard Smith, J. 1982. *Evolution and the Theory of Games*. Cambridge: Cambridge University Press.

Mayr, E. 1959. Typological versus Population Thinking. In: B.J. Meggers (ed.), *Evolution and Anthropology: A Centennial Appraisal*, pp. 409-412. Washington D.C.: Anthropological Society of Washington.

Mayr, E. 1976 [1957]. Species concepts and definitions. In: E. Mayr (ed.), *The species problem*, pp.

1-22. Washington, D.C: American Association for the Advancement of Science.

Mayr, E. 1988. *Toward a new philosophy of biology: Observations of an evolutionist*. Cambridge (MA): Harvard University Press.

Mayr, E. 1991. *One Long Argument*. Cambridge (MA): Harvard University Press.

McCall, G.S. 2006. Multivariate perspectives on change and continuity in the Middle Stone Age lithics from Klasies River Mouth, South Africa. *Journal of Human Evolution* 51: 429-439.

McCall, G.S. 2007. Behavioral ecological models of lithic technological change during the later Middle Stone Age of South Africa. *Journal of Archaeological Science* 34: 1738-1751.

McCall, G.S. 2012. Ethnoarchaeology and the Organization of Lithic Technology. *Journal of Archaeological Research* 20: 157-203.

McCall, G.S. 2015. *Before Modern Humans. New Perspectives on the African Stone Age*. Walnut Creek (CA): Left Coast Press.

McGrew, W.C. 1992. *Chimpanzee Material Culture: Implications for Human Evolution*. Cambridge: Cambridge University Press.

McLaughlin, B., K. Bennett 2018. Supervenience. In: E.N. Zalta (ed.), The Stanford Encyclopedia of Philosophy (Spring 2018 Edition): URL = https://plato.stanford.edu/archives/spr2018/entries/supervenience/. [last access 30.07.2018]

McNabb, J. 2007. *The British Lower Palaeolithic. Stones in Contention*. London: Routledge.

McNabb, J. 2012a. *Dissent with Modification. Human Origins, Palaeolithic Archaeology, and Evolutionary Anthropology in Britain 1859-1901*. Oxford: Archaeopress.

McNabb, J. 2012b. The importance of conveyIng visual Information in Acheulean society. The background to the visual display hypothesis. In: J. Cole, K. Ruebens (eds.), *Human Origins. Volume 1*, pp. 1-23. Oxford: Archaeopress.

McNabb, J. 2013. Pole to Pole. Archaeology and Adaptation in the Middle Pleistocene at Opposite Ends of the Acheulean World. *Oxford Journal of Archaeology* 32(2): 123-146.

McNabb, J. 2017. Journeys in space and time. Assessing the link between Acheulean handaxes and genetic explanations. *Journal of Archaeological Science: Reports* 13: 403-414.

McNabb, J., J. Cole 2015. The mirror cracked: Symmetry and refinement in the Acheulean handaxe. *Journal of Archaeological Science: Reports* 3: 100-111.

McNabb, J., F. Binyon, L. Hazelwood 2004. Large cutting tools from the South African Acheulean and the question of social traditions. *Current Anthropology* 45(5): 653-668.

McNabb, J., J. Cole, C.S.Hoggard 2018. From side to side: Symmetry in handaxes in the British Lower and Middle Palaeolithic. *Journal of Archaeological Science: Reports* 17: 293-310.

McPherron, S.P. 1991. Digitalisation d'images et analyse des materiaux lithiques. In: A. Tuffreau (ed.), *Paléolithique et mésolithique du Nord de la France: Nouvelles recherches: II*, pp. 21-26. Villeneuve d'Ascq: Centre d'études et de recherches préhistoriques, Université des sciences et technologies de Lille.

McPherron, S.P. 1994. *A Reduction Model for Variability in Acheulean Biface Morphology*. Unpublished Doctoral Dissertation, University of Pennsylvania.

McPherron, S.P. 1999. Ovate and Pointed Handaxe Assemblages: Two Points Make A Line. *Préhistoire Européenne* 14: 9-32.

McPherron, S.P. 2000. Handaxes as a measure of the mental capabilities of early hominids. *Journal of Archaeological Science* 27(8): 655-664.

McPherron S.P. 2003. Typological and Technological Variability in the Bifaces from Tabun Cave, Israel. In: M. Soressi, H.L. Dibble (eds.), *From Prehistoric Bifaces to Human Behavior: Multiple Approaches to the study of Bifacial Technology*, pp. 55-76. Philadelphia: University of Pennsylvania Museum Press.

McPherron, S.P. 2006. What typology can tell us about Acheulian handaxe production. In: N. Goren-Inbar, G. Sharon (ed.), *Axe age: Acheulian tool-making from quarry to discard*, pp. 267-286. London: Equinox.

McPherron, S.P. 2018. Additional statistical and graphical methods for analyzing site formation processes using artifact orientations. *PLoS ONE* 13(1): e0190195.

McPherron, S.P., H.L. Dibble 2002. *Using Computers in Archaeology: A Practical Guide*. New York: McGraw Hill.

McPherron, S.P., D.R. Braun, T. Dogandžić, W. Archer, D. Desta, S.C. Lin 2014. An experimental assessment of the influences on edge damage to lithic artifacts: a consideration of edge angle, substrate grain size, raw material properties, and exposed face. *Journal of Archaeological Science* 49: 70-82.

McPherron, S.P., H.L. Dibble, D.M. Sandgathe, P. Goldberg, S.C. Lin, A. Turq 2018. The Lithic Assemblages. In: H.L. Dibble, S.J.P. McPherron, P. Goldberg, D.M. Sandgate (eds.), *The Middle Paleolithic Site of Pech de l'Azé IV*, pp. 117-219. New York: Springer.

Meignen, L. 1988. Un exemple de comportement technologique différentiel selon les matières premières : Marillac, couches 9 et 10. In: M. Otte (ed.), *L'Homme de Néandertal, vol. 4 : La Technique*, pp. 71-79. Liège: ERAUL 31.

Meignen, L., A. Delagnes, L. Bourguignon 2009. Patterns of Lithic Material Procurement and Transformation During the Middle Paleolithic in Western Europe. In: B. Adams, B.S. Blades (eds.), *Lithic Materials and Paleolithic Societies*, pp. 15-24. Chichester: Willey-Blackwell.

Meillassoux, Q. 2008 [2006]. *After Finitude. An Essay on the Necessity of Contingeny*. Translated from the French by Ray Brassier. London: Bloomsbury Publishing.

Mellars, P. 1969. The Chronology of Mousterian Industries in the Perigord Region of South-West France. *Proceedings of the Prehistoric Society* 35: 134-171.

Mellars, P. 1970. Some Comments on the Notion of "Functional Variability" in Stone-Tool Assemblages. *World Archaeology* 2: 74-89.

Mellars, P. 1989. Technological changes and the Middle-Upper Paleolithic transition: economics, social and cognitive perspectives. In: P. Mellars, C. Stringer (eds.), *The Human Revolution*, pp. 338-365. Edinburgh: Edinburgh University Press.

Mellars, P. 1996. *The Neanderthal Legacy: An Archaeological Perspective from Western Europe*. Princeton: Princeton University Press.

Mellars, P. 2002. The impact of climatic changes on the demography of late Neandertal and early anatomically modern populations in Europe. In: T. Akazawa, K. Aoki, Kenichi, O. Bar-Yosef (eds.), *Neandertals and modern humans in Western Asia*, pp. 493-507. New York: Springer.

Mellars, P. 2006. Foreword: Challenges and Approaches in the Study of Middle Paleolithic Behavioral Change. In: E. Hovers, S.L. Kuhn (eds.), *Transitions Before the Transition. Evolution and Stability in the Middle Paleolithic and Middle Stone Age*, pp. vii-xvii. New York: Springer.

Mellars, P. 2009. Cognition and climate: why is Upper Palaeolithic cave art almost confined to the Franco-Cantabrian region? In: C. Renfrew, I. Morley (eds.), *Becoming Human. Innovation in Prehistoric Material and Spiritual Culture*, pp. 212-231. Cambridge: Cambridge University Press.

Mellars, P., K.R. Gibson (eds.) 1996. *Modelling the Early Human Mind*. Cambridge: McDonald Institute Monographs.

Meltzer, D.J. 1979. Paradigms and the nature of change in American archaeology. *American Antiquity* 44: 644-657.

Meltzer, D.J. 2011. Lewis Roberts Binford 1931–2011. *Biographical Memoir, National Academy of Sciences*. Washington D.C.

Merton, R.K. 1949 [1968]. *Social Theory and Social Structure*. New York: Free Press.

Mesoudi, A. 2011. *Cultural Evolution: How Darwinian Theory Can Explain Human Culture and Synthesize the Social Sciences*. Chicago: University of Chicago Press.

Mesoudi, A. 2016. Cultural Evolution: A Review of Theory, Findings and Controversies. *Evolutionary Biology* 43(4): 481-497.

Mesoudi, A., A. Withen, K.N. Laland 2006. Towards a unified science of cultural evolution. *Behavioral and Brain Sciences* 29(4): 329-347.

Mevel, L. 2010. *Des sociétés en mouvement : nouvelles données sur l'évolution des comportements techno-économiques des sociétés magdaléniennes et aziliennes des Alpes du nord françaises (14 000 -11000 BP).* Unpublished Doctoral Dissertation, Université de Paris X-Nanterre.

Mevel, L. 2013. Les premières sociétés aziliennes : nouvelle lecture de la genèse du phénomène d'azilianisation dans les Alpes du Nord à partir des deux niveaux d'occupation de l'abri de La Fru (Saint-Christophe-la-Grotte, Savoie). *Bulletin de la Société préhistorique française* 110(4): 657-689.

Mevel, L. 2017. *Sociétés en Mouvement. Évolution des Sociétés Magdaléniennes et Aziliennes des Alpes du Nord Françaises*. Paris: CTHS.

Meyer, W.B., D.M.T. Guss 2017. Neo-Environmental Determinism. In: W.B. Meyer, D.M.T. Guss (eds.), *Neo-Environmental Determinism. Geographical Critiques*, pp. 39-96. New York: Springer.

Miller, M.C. 1997. *Athens and Persia in the fifth century BC: A Study in Cultural Receptivity*. Cambridge: Cambridge University Press.

Miracle, P.T. 1995. *Broad-Spectrum Adaptations Re-Examined: Hunter-Gatherer Responses to Late Glacial Environmental Changes in the Eastern Adriatic*. Unpublished Doctoral Dissertation, University of Michigan.

Mithen, S. 1990. *Thoughtful Foragers: A Study of Prehistoric Decision Making*. Cambridge: Cambridge University Press.

Mithen, S. 1996. *The Prehistory of the Mind. A Search for the Origins of Art, Religion and Science*. London: Thames & Hudson.

Mithen, S. 2003. Handaxes: The First Aesthetic Artefacts. In: E. Voland, K. Grammer (eds.), *Evolutionary Aesthetics*, pp. 261-275. Berlin: Springer.

Miquel, P.-A. 2007. Bergson and Darwin: From an Immanentist to an Emergentist Approach to Evolution. *SubStance* 36(3): 42-56.

Monast, J.H. 1975. *Evidence, Common Sense, and Metaphysical Systems: The Philosophical Methodology of Stephen C. Pepper*. Unpublished Doctoral Dissertation, Tulane University.

Moncel, M.-H. 2003. *L'exploitation de l'espace et la mobilité des groupes humains au travers des assemblages lithiques à la fin du Pléistocène moyen et au début du Pléistocène supérieur. La moyenne vallée du Rhône entre Drôme et Ardèche*. BAR International Series 1184. Oxford: Archaeopress.

Moncel, M.-H., C. Daujeard 2012. The variability of the Middle Palaeolithic on the right bank of the Middle Rhône Valley (southeast France): Technical traditions or functional choices? *Quaternary International* 247: 103-124.

Moncel, M.-H., M. Arzarello, E. Boëda, S. Bonilauri, B. Chevrier, C. Gaillard, H. Forestier, Li Yinghua, F. Sémah, V. Zeitoun 2016a. The assemblages with bifacial tools in Eurasia (first part). What is going on in the West? Data on western and southern Europe and the Levant. *Comptes Rendus Palevol* [in press].

Moncel, M.-H., M. Arzarello, E. Boëda, S. Bonilauri, B. Chevrier, C. Gaillard, H. Forestier, Li Yinghua, F. Sémah, V. Zeitoun 2016b. Assemblages with bifacial tools in Eurasia (second part). What is going on in the East? Data from India, Eastern Asia and Southeast Asia. *Comptes Rendus Palevol* [in press].

Moncel, M.-H., M. Arzarello, E. Boëda, S. Bonilauri, B. Chevrier, C. Gaillard, H. Forestier, Li Yinghua, F. Sémah, V. Zeitoun 2016c. Assemblages with bifacial tools in Eurasia (third part). Considerations on the bifacial phenomenon throughout Eurasia. *Comptes Rendus Palevol* [in press].

Monigal, K. 2002. *The Levantine Leptolithic Blade Production from the Lower Paleolithic to the Dawn of the Upper Paleolithic*. Unpublished Doctoral Dissertation, Southern Methodist University (Dallas).

Monnier, G.F. 2009. Commentary following O. Bar-Yosef, P. Van Peer, The Chaîne Opératoire Approach in Middle Paleolithic Archaeology. *Current Anthropology* 50(1): 103-131 [121-122].

Monnier, G.F., K. Missal 2014. Another Mousterian Debate? Bordian facies, *chaîne opératoire* technocomplexes, and patterns of lithic variability in the western European Middle and Upper Pleistocene. *Quaternary International* 350: 59-83.

Montoya, C. 2004. *Les traditions techniques lithiques à l'épigravettien : analyses de séries du tardiglaciaire entre Alpes et Méditerranée*. Unpublished Doctoral Dissertation, Université de Provence – Aix-Marseille I.

Moore, G. 2013. Adapt and Smile or Die! Stiegler among Darwinists. In: G. Moore, C. Howells (eds.), *Stiegler and Technics*, pp. 17-33. Edinburgh: Edinburgh University Press.

Morsink, J. 2018. Catalytic Environments. *Environmental Archaeology: The Journal of Palaeoecology*: DOI: 10.1080/14614103.2018.1440690.

Mourre, V. 2003. Discoïde ou pas Discoïde ? Réflexions sur la pertinence des critères techniques définissant le débitage Discoïde. In: M. Peresani (ed.), *Discoid Lithic Technology - Advances and implications*, pp. 1-18. BAR International Series 1120. Oxford: Archaeopress.

Muller, A., C. Clarkson, C. Shipton 2017. Measuring behavioural and cognitive complexity in lithic technology throughout human evolution. *Journal of Anthropological Archaeology* 48: 166-180.

Müller, B. 2007. *Kosmik. Prozeßontologie und temporale Poetik bei Ludwig Klages und Alfred Schuler: Zur Philosophie und Dichtung der Schwabinger Kosmischen Runde*. Munich: Telesma.

Murray, T. 1993. Communication and the importance of disciplinary communities: who owns the past?. In: N. Yoffee, A. Sherratt (eds.), *Archaeological theory: who sets the agenda?*, pp. 105-116. Cambridge: Cambridge University Press.

Murray, T. 2013. Why the history of archaeology is essential to theoretical archaeology. *Complutum* 24(2): 21-31.

Murray, T. 2014. *From Antiquarian to Archaeologist: The History and Philosophy of Archaeology*. Barnsley: Penn and Sword.

Murray, T. 2017. The origins of culture history in prehistoric archaeology: rethinking plausibility and disciplinary tradition. *World Archaeology* 49: 187-197.

Nagel, J. 2007. Epistemic Intuitions. *Philosophy Compass* 2(6): 792-819.

Nahler, S.E. 1991. *Curation during the Middle Paleolithic: A reasonable research focus?* Unpublished Master Dissertation, University of Arizona.

Nash, J. 1950. Equilibrium points in n-person games. *Proceedings of the National Academy of Sciences of the United States of America* 36(1): 48-49.

Naudinot, N. 2010. *Dynamiques techno-économiques et de peuplement au Tardiglaciaire dans le Grand-Ouest de la France*. Unpublished Doctoral Dissertation, Université de Rennes 1.

Naudinot, N., A. Tomasso, E. Messager, W. Finsinger, P. Ruffaldi, M. Langlais 2017a. Between Atlantic and Mediterranean: Changes in technology during the Late Glacial in Western Europe and the climate hypothesis. *Quaternary International* 428: 33-49.

Naudinot, N., C. Bourdier, M. Laforge, C. Paris, L. Bellot-Gurlet, S. Beyries, I. Thery-Parisot, M. Le Goffic 2017b. Divergence in the evolution of Paleolithic symbolic and technological systems: The shining bull and engraved tablets of Rocher de l'Impératrice. *PLoS ONE* 12(3): e0173037.

Neeley, M.P., C.M. Barton 1994. A new approach to interpreting late Pleistocene microlith industries in southwest Asia. *Antiquity* 68: 275-288.

Nelson, M. 1991. The Study of Technological Organization. *Archaeological Method and Theory* 3: 57-100.

Nettle, D., M.A. Gibson, D.W. Lawson, R. Sear 2013. Human behavioral ecology: current research and future prospects. *Behavioral Ecology* 24(5): 1031-1040.

Ney, A. 2009. Physical Causation and Difference-Making. *British Journal for the Philosophy of Science* 60: 737-764.

Nickles, T. 2013. Context of Discovery Versus Context of Justification. In: B. Kaldis (ed.), *Encyclopedia of Philosophy and the Social Sciences*, pp. 153-155. Los Angeles: Sage Publications.

Nicoud, E. 2011. *Le phénomène acheuléen en Europe occidentale : approche chronologique, technologie lithique et implications culturelles*. Doctoral Dissertation, Université de Provence.

Nicoud, E. 2013. What Does the Acheulean Consist of? The Example of Western Europe (MIS 16-9). *Mitteilungen der Gesellschaft für Urgeschichte* 22: 41-60.

Nicoud, E., D. Aureli, M. Pagli, V. Villa, C. Chauss, S. Agostini, J.-J. Bahain, G. Boschian, J.-P. Degeai, F. Fusco, B. Giaccio, M. Hernandez, C. Kuzucuoglu, C. Lahaye, C. Lemorini, N. Limondin-Lozouet, A. Pereira, P. Mazza, V. Robert, N. Mercier, M.A. Rossi, S. Nomade, C. Virmoux, A. Zupancich 2016. Preliminary data from Valle Giumentina Pleistocene site (Abruzzo, Central Italy): A new approach to a Clactonian and Acheulian sequence. *Quaternary International* 409: 182-194.

Norris, C. 2005. Hermeneutic circle. In: T. Honderich (ed.), The Oxford Companion to Philosophy, 2nd Edition, pp. 379-380. Oxford: Oxford University Press.

Norton, D.L. 1995. Review of M. Krausz, Rightness and Reasons: Interpretation in Cultural Practices. Ithaca, London: Cornell University Press, 1993. Pp. xii, 169. *Philosophy and Phenomenological Research* 55(3): 711-715.

Nowell, A. 2000. *The Archaeology of Mind: Standardization and Symmetry in Lithics and Their Implications for the Study of the Evolution of the Human Mind*. Unpublished Doctoral Dissertation, University of Pennsylvania.

O'Brien, M.J. 2010. The Future of Paleolithic Studies: A View from the New World. In: S.J. Lycett, P.R. Chauhan (eds.), *New Perspectives on Old Stones. Analytical Approaches to Paleolithic Technologies*, pp. 311-334. New York: Springer.

O'Brien, M.J., R.L. Lyman (eds.) 2003. *Style, Function, Transmission: Evolutionary Archaeological Perspectives*. Salt Lake City: University of Utah Press.

O'Brien, M.J., S.J. Shennan 2010. Issues in Anthropological Studies of Innovation. In: M.J. O'Brien, S.J. Shennan (eds.), *Innovation in Cultural Systems. Contributions from Evolutionary Anthropology*, pp. 3-17. Cambridge (MA): MIT Press.

O'Brien, M.J., M. Collard, B. Buchanan, M.T. Boulanger 2013. Trees, thickets, or something in between? Recent theoretical and empirical work in cultural phylogeny. *Israel Journal of Ecology and Evolution* 59(2): 45-61.

O'Connell, J.F. 1995. Ethnoarchaeology Needs a General Theory of Behavior. *Journal of Archaeological Research* 3(3): 205-255.

O'Connell, J.F. 2006. How did modern humans displace Neanderthals? Insights from hunter-gatherer ethnography and archaeology. In: N.J. Conard (ed.*), When Neanderthals and modern humans met*, pp. 43-64. Tübingen: Kerns.

O'Connor, A. 2007. *Finding Time for the Old Stone Age. A History of Palaeolithic Archaeology and Quaternary Geology in Britain, 1860-1960*. Oxford: Oxford University Press.

Odell, G.H. 2001. Stone Tool Research at the End of the Millennium: Classification, Function, and Behavior. *Journal of Archaeological Research* 9(1): 45-100.

Oevermann, U. 2001. *Strukturprobleme supervisorischer Praxis. Eine objektiv hermeneutische Sequenzanalyse zur Überprüfung der Professionalisierungstheorie*. Frankfurt am Main: Humanities Online.

O'Farrell, M. 2004. Les pointes de La Gravette de Corbiac (Dordogne) et considérations sur la chasse au Paléolithique supérieur ancien. In: P. Bodu, C. Constantin (eds.), *Approches fonctionnelles en préhistoire*, pp. 121-138. Paris: Société préhistorique française.

O'Higgins, P. 2000. The study of morphological variation in the hominid fossil record: biology, landmarks and geometry. *Journal of Anatomy* 197: 103-120.

O'Higgins, P., N. Jones 2006. *Tools for Statistical Shape Analysis*. Hull York Medical School. [freely available software package *Morphologika*]

Olesen, S.H. 2013. The societal nature of subjectivity: an interdisciplinary methodological challenge. *Historical Social Research* 38(2): 7-25.

Olsen, W., J. Morgan 2005. A Critical Epistemology of Analytical Statistics: Addressing the Sceptical Realist. *Journal for the Theory of Social Behaviour* 35(3): 256-284.

Olive, M. 2005. La perception du temps dans les sites magdaléniens de plein air du Bassin parisien. Du temps d'une occupation au temps des occupations. L'exemple du site d'Étiolles. *Bulletin de la Société préhistorique française* 102(4): 763-770.

Olive, M., N. Pigeot 2006. Réflexions sur le temps d'un séjour à Étiolles (Essonne). *Bulletin de la Société préhistorique français* 103(4): 673-682.

Olivier, L. 1999. The origins of French archaeology. *Antiquity* 73: 176-183.

Olszewski, D.I. 1993. Zarzian microliths from Warwasi Rockshelter, Iran: scalene triangles as arrow components. In: G. Larsen-Peterkin, H.M. Bricker, P.A. Mellars (eds.), *Hunting and animal exploitation in the later Paleolithic and Mesolithic of Eurasia*, pp. 199–205. Tempe: American Anthropological Association.

Olszewski, D.I. 2016. Reductive technology and the early Epipaleolithic of the Middle East and North Africa. In: A. Sullivan III., D.I. Olszewski (eds.), *Archaeological Variability and Interpretation in Global Perspective*, pp. 71-98. Boulder: University of Colorado Press.

Orton, C. 2000. *Sampling in Archaeology*. Cambridge: Cambridge University Press.

Oswalt, W.H. 1974. *Habitat and technology: the evolution of hunting*. New York: Holt, Rinehart, and Winston.

Oswalt, W.H. 1976. *An anthropological analysis of food-getting technology*. New York (NY): Wiley.

Otte, M. 1991. Relations Technologie-Typologie en Préhistoire. *Anthropologie* 29(1/2): 127-130.

Otte, M., L.H. Keeley 1990. The Impact of Regionalism on Palaeolithic Studies. Current Anthropology 31(5): 577-582.

Overton, W.F. 2007. A Coherent Metatheory for Dynamic Systems: Relational Organicism-Contextualism. *Human Development* 50: 154-159.

Pagli, M. 2009. An approach to the Quina variability. Contributions of techno-functional analysis to understanding the diversity of Quina type industries: the case of Le Fond des Blanchards at Gron (France). *Human Evolution* 24(1): 77-90.

Pappas, G. 2017. Internalist vs. Externalist Conceptions of Epistemic Justification. In: E.N. Zalta (ed.), *The Stanford Encyclopedia of Philosophy* (Fall 2017 Edition): URL = https://plato.stanford.edu/archives/fall2017/entries/justep-intext/ [last access 28.07.2018].

Patou-Mathis, M., P. Auguste, A. Averbough, P. Bodu, É. David, G. Giacobini, C. Leroy-Prost, G. Malerba, C. Schwab, P. Valensi (eds.) 2002. *Os 10 - Compresseurs, percuteurs, retouchoirs*. Paris: Société préhistorique française.

Patrik, L. 1985. Is There an Archaeological Record? *Advances in Archaeological Method and Theory* 8: 27-62.

Pelcin, A.W. 1997. The Effect of Core Surface Morphology on Flake Attributes: Evidence from a Controlled Experiment. *Journal of Archaeological Science* 24: 749-756.

Pelegrin, J. 1986. *Technologie lihtique : une méthode appliquée à l'étude de deux séries du Périgordien ancien ; Roc-de-Combe couche 8, La Côte niveau III*. Doctoral Dissertation, Université Paris X-Nanterre.

Pelegrin, J. 1988. Technologie. In: A. Leroi-Gourhan (ed.), *Dictionnaire de la Préhistoire*, p. 1030. Paris: PUF.

Pelegrin, J. 1990. Prehistoric lithic technology: some aspects of research. *Archaeological Review from Cambridge* 9(1): 116-125.

Pelegrin, J. 1991. Les savoir-faire: une très longue histoire. *Terrain, Carnets du Patrimoine Ethnologique* 6: 106-113.

Pelegrin, J. 1995. *Technologie lithique : le Châtelperronien de Roc-de-Combe (Lot) et de La Côte (Dordogne)*. Paris: Éditions de CNRS.

Pelegrin, J. 2000. Les techniques de débitage laminaire au Tardiglaciaire: critères de diagnose et quelques réflexions. In: B. Valentin, P. Bodu, M. Christensen (eds.), *L'Europe Centrale et Septentrionale au Tardiglaciaire*, pp. 73-86. Nemours: A.P.R.A.I.F.

Pelegrin, J. 2004. Le milieu intérieur d'André Leroi-Gourhan et l'analyse de la taille de pierre au Paléolithique. In: F. Audouze, N. Schlanger (eds.), *Autour de l'homme. Contexte et actualité d'André Leroi-Gourhan*, pp. 149-160. Antibes: Éditions APDCA.

Pelegrin, J. 2005. Remarks About Archaeological Techniques and Methods of Knapping: Elements of a Cognitive Approach to Stone Knapping. In: V. Roux, B. Bril (eds.), *Stone Knapping, the Necessary Conditions for a Uniquely Hominin Behavior*, pp. 23–34. Cambridge: McDonald Institute for Archaeological Research.

Pelegrin, J. 2006a. Sur le débitage laminaire de Corbiac et sur les débitages laminaires du Paléolithique supérieur. *Unpublished conference presentation issued at the round table « Le phénomène laminaire au Paléolithique moyen et supérieur en Eurasie »*, 6th to 7th of April 2006.

Pelegrin, J. 2006b. Long Blade Technology in the Old World: An Experimental Approach and some Archaeological Results. In: J. Appel, k. Knutsson (eds.), *Skilled Production and Social Reproduction*, pp, 37-68. Uppsala: Societas Archaeologica Usppsaliensis.

Pelegrin, J. 2007. À quoi servaient ces pierres taillées exceptionnelles ? *Archeologia* 444: 40-41.

Pelegrin, J. 2011. Sur les débitages laminaires du Paléolithique supérieur. In: F. Delpech, J. Jaubert (eds.), *François Bordes et la Préhistoire*, pp. 142-152. Paris: Éditions du C.T.H.S.

Pelegrin, J. 2013. Les grandes feuilles de laurier et autres objets particuliers du Solutréen : une valeur de signe. In: Société d'études et de recherche archéologiques sur le Paléolithique de la vallée de la Claise (ed.), *Le Solutréen, 40 ans après Smith'66*, pp. 143-164. Tours: R.A.C.F.

Pelegrin, J., M. O'Farrell 1998. Quelques éléments sur l'industrie lithique et sur les raccords. In: J. Pelegrin, R. White (eds.), *Abri Castanet (Sergeac, Dordogne), rapport de fouille programmée triannuelle (1996-1998)*. Unpublished Document.

Pelegrin, J., C. Karlin, P. Bodu 1988. Chaînes opératoires : un outil pour le prehistorien. In: J. Tixier (ed.), *Technologie préhistorique*, pp. 55-62. Paris: Éditions du C.N.R.S.

Pepper, S.C. 1928. Philosophy and Metaphor. *The Journal of Philosophy* 25(5): 130-132.

Pepper, S.C. 1935a. The Root of Metaphor Theory of Metaphysics. *The Journal of Philosophy* 32(14): 365-374.

Pepper, S.C. 1935b. The Order of Time. *University of California Publications in Philosophy* XVIII: 16.

Pepper, S.C. 1936. On the Cognitive Value of World Hypotheses. *The Journal of Philosophy* 33(21): 575-577.

Pepper, S.C. 1942. *World hypotheses. Prolegomena to systematic philosophy and a complete survey of metaphysics*. Berkeley: University of California Press.

Pepper, S.C. 1943. The Status of "World Hypotheses": A Rejoinder. *The Philosophical Review* 52(6): 602-604.

Pepper, S.C. [1945] 1963. *The Basis of Criticism in the Arts*. Cambridge (MA): Harvard University Press.

Pepper, S.C. 1967. *Concept and Quality. A World Hypothesis*. La Salle (IL): Open Court.

Pepper, S.C. 1970. Letter to Arthur Efron, June 5th, 1970. Cited in Efron 1980: 32, footnote 109.

Perlès, C. 1974. Importance et évolution de l'outil préhistorique. *Archives des Maladies Professionnelles* 35(9): 816-818.

Perlès, C. 1977. Note préliminaire sur un type d'outil particulier du site d'Orville (Indre). *Bulletin de la Société préhistorique française* 74(5): 141-144.

Perlès, C. 1980. Économie de la matière première et économie du débitage: deux exemples grecs. In: J. Tixier (ed.), *Préhistoire et Technologie lithique*, vol 1, pp. 37-41. Paris: Centre régional de publication de Sophia Antipolis.

Perlès, C. 1982. Les « outils d'Orville » : des nucléus à lamelles. In: D. Cahen (ed.), *Tailler ! Pour quoi faire : Préhistoire et technologie lithique / Recent progress in microwear studies*, pp. 29-148. Tervuren: Musée Royal de l'Afrique Centrale.

Perlès, C. 1987. *Les industries lithiques taillées de Franchthi (Argolide, Grece), tome I : présentation générale et industries paléolithiques*. Bloomington/Indianapolis: Indiana University Press.

Perlès, C. 1988. Typologie. In: A. Leroi-Gourhan (ed.), *Dictionnaire de la Préhistoire*, p. 1080. Paris: PUF.

Perlès, C. 1991a. Introduction. In: C. Perlès (ed.), *25 Ans d'étude technologique en préhistoire. Bilan et perspectives*, pp. 7-10. Juan-les-Pins: Éditions APDCA.

Perlès, C. 1991b. Économie des matières premières et économie du débitage : deux conceptions opposées? In: C. Perlès (ed.), *25 Ans d'étude technologique en préhistoire. Bilan et perspectives*, pp. 35-45. Juan-les-Pins: Éditions APDCA.

Perlès C. 1992. In Search of Lithic Strategies: a Cognitive Approach to Prehistoric Chipped Stone Assemblages. In: C. Peebles, J.-C. Gardin (eds.), *Representations in Archaeology*, pp. 223-247. Bloomington: Indiana University Press.

Perlès, C. 1993. Ecological determinism, group strategies, and individual decisions in the conception of prehistoric stone assemblages. In: A. Berthelet, J. Chavaillon (eds.), *The use of tools by human and non-human primates*, pp. 267-280. Gloucestershire: Clarendon Press.

Perlès, C. 1998. Conceptions du temps et changement culturel en préhistoire. In: Collectif (eds.), *Le Temps*, pp. 17-22. Paris: Ministère de l'Éducation nationale, de la recherche et de la technologie, Institut Universitaire de France.

Perlès, C. 2009. Les industries lithiques néolithiques : logiques techniques et logiques sociales. In: Collectif (eds.), *De Méditerranée et d'ailleurs… Mélanges offerts à Jean Guilaine*, pp. 557-571. Toulouse: Archives d'Écologie Préhistorique.

Perlès, C. 2013. Tempi of Change: When Soloists don't play Together. Arrhythmia in 'Continuous' Change. *Journal of Archaeological Method and Theory* 20: 281-299.

Perlès, C. 2016. La technologie lithique, de part et d'autre de l'Atlantique/ Paths that rarely cross: approaches to lithic technology across the Atlantic. *Bulletin de la Société préhistorique française* 113(2): 221-240.

Perlès, C., M. Vanhaeren 2012. A. Gallay (2011) – *Pour une ethnoarchéologie théorique. Bulletin de la Société préhistorique française* 109(4): 796-797.

Perreault, C., P.J. Brantingham, S.L. Kuhn, S. Wurz, X. Gao 2013. Measuring the Complexity of Lithic Technology. *Current Anthropology* 54(8): 397-406.

Pesesse, D. 2002. *Les burins de l'unité OP10 de la Vigne Brun (Loire) : Caractérisation technologique de la variabilité typologiques*. Unpublished Master Dissertation, Université de Provence.

Pesesse, D. 2010. Quelques repères pour mieux comprendre l'émergence du Gravettien en France. *Bulletin de la Société préhistorique française* 107(3): 465-487.

Pesesse, D., A. Michel 2006. Le burin des Vachons : apports d'une relecture technologique à la compréhension de l'Aurignacien récent du Nord de l'Aquitaine et des Charentes. *Paléo* 18: 143-160.

Peters, C.R., R.J. Blumenschine 1995. Landscape perspectives on possible land use patterns for early hominids in the Olduvai Basin. Journal of Human Evolution 29: 321-362.

Peters, C.R., R.J. Blumenschine 1996. Landscape perspectives on possible land use patterns for Early Pleistocene hominids in the Olduvai Basin, Tanzania: Part II, expanding the landscape models. In: C. Magori, C.B. Saanane, F. Schrenk (eds.), *Four Million Years of Hominid Evolution in Africa: Papers in Honour of Dr Mary*

Douglas Leakey's Outstanding Contribution in Paleoanthropology, pp. 175- 221. Darmstadt: Darmstadter Beiträge zur Naturgeschichte.

Peters, R.H. 1991. *A Critique for Ecology*. Cambridge: Cambridge University Press.

Pétillon, J.-M., S. Ducasse 2012. From flakes to grooves: A technical shift in antlerworking during the last glacial maximum in southwest France. *Journal of Human Evolution* 62: 435-465.

Pettitt, P.B. 2003. The Mousterian in Action: Chronology, Mobility, and Middle Palaeolithic Variability. In: N. Moloney, M.J. Shott (eds.), *Lithic Analysis at the Milennium*, pp. 29-44. London: Institute of Archaeology (UCL).

Pettitt, P.B., M. White 2012. *The British Palaeolithic. Human Societies at the Edge of the Pleistocene World*. London: Routlegde.

Petraglia, M.D. 2006. The Indian Acheulean in global perspective. In: N. Goren-Inbar, G. Sharon (eds.), *Axe-Age: Acheulean tool-making from quarry to discard*, pp. 389-414. London: Equinox Publishing

Petraglia, M.D., R. Korisettar (eds.) 1998. *Early Human Behaviour in Global Context: The Rise and Diversity of the Lower Palaeolithic Record*. London: Routledge.

Petraglia, M.D., B. Allchin (eds.) 2007. *The Evolution and History of Human Populations in South Asia. Inter-disciplinary Studies in Archaeology, Biological Anthropology, Linguistics and Genetics*. Dordrecht: Springer.

Petraglia, M.D., C. Shipton 2008. Large cutting tool variation west and east of the Movius Line. *Journal of Human Evolution* 55(6): 962-966.

Petraglia, M.D., J.I. Rose (eds.) 2010. *The Evolution of Human Populations in Arabia. Paleoenvironments, Prehistory and Genetics*. Dordrecht: Springer.

Petraglia, M.D., N. Boivin 2014. Homo sapiens societies: South Asia. In: V. Cummings, P. Jordan, M. Zvelebil (eds.), *The Oxford Handbook of the Archaeology and Anthropology of Hunter-Gatherers*, pp. 328-345. Oxford: Oxford University Press.

Petraglia, M.D., R. Korisettar, N. Boivin, C. Clarkson, P. Ditchfield, S. Jones, J. Koshy, M.M. Lahr, C. Oppenheimer, D. Pyle, R. Roberts, J.-L. Schwenninger, L. Arnold, K. White 2007. Middle Paleolithic Assemblages from the Indian Subcontinent Before and After the Toba Super-Eruption. *Science* 317: 114-116.

Petraglia, M.D., C. Clarkson, N. Boivin, M. Haslam, R. Korisettar, G. Chaubey, P. Ditchfield, D. Fuller, H. James, S. Jones, T. Kivisild, J. Koshy, M.M. Lahr, M. Metspalu, R. Roberts, L. Arnold 2009a. Population increase and environmental deterioration correspond with microlithic innovations in South Asia ca. 35,000 years ago. *PNAS* 106(30): 12261-12266.

Petraglia, M.D., R. Korisettar, M. Katsuri Bai, N.B.J. Boivin, C. Clarkson, K. Cunningham, P. Ditchfield, D. Fuller, J. Hampson, M. Haslam, S. Jones, J. Koshy, P. Miracle, C. Oppenheimer, R. Roberts, K. White 2009b. Human occupation, adaptation and behavioural change in the Pleistocene and Holocene of South India: recent investigations in the Kurnool District, Andhra Pradesh. *Journal of Eurasian Prehistory* 6(1-2): 19-166.

Piaget, J. 1952. *The Origin of Intelligence in Children*. New York: International University Press.

Piaget, J. 1964 [1959]. *The Early Growth of Logic in the Child*. London: Routledge/Kegan Paul Ltd. [Originally published in 1959 as "La génèse des structures logiques élémentaires" together with Bärbel Inhelder]

Pickering, A. 1995. *The Mangle of Practice. Time, Agency, and Science*. Chicago: The University of Chicago Press.

Pickering, T.R., J. Wallis 1997. Bone modification resulting from captive chimpanzee mastication: implications for the interpretation of Pliocene archaeological faunas. *Journal of Archaeological Science* 24: 1115-1127.

Pickering, T.R., K. Schick, N. Toth (eds.) 2007. *Breathing Life into Fossils: Taphonomic Studies in Honor of C.K.* (Bob) Brain, pp. 281-296. Gosport (IN): Stone Age Institute Press.

Pierce, C.S. 1901. Truth and Falsity and Error. In: J.M. Baldwin (ed.), *Dictionary of Philosophy and Psychology, vol. 2*, pp. 716-720. New York: Macmillan.

Piette, A. 2010. *Propositions anthropologiques pour refonder la discipline*. Paris: Pétra.

Piette, A. 2011. *Fondements à une anthropologie des hommes*. Paris: Éditions Hermann.

Piette, A. 2016. *Separate Humans. Anthropology, Ontology, Existence*. Milan: Mimesis International.

Piette, A. 2017. Theoretical Principles of Anthropology as a Science of Human Beings. *Yearbook of the Centre for Cosmopolitan Studies* 2017(3): 1-36.

Pigeot, N. 1983. *Les Magdaléniens de l'Unité U5 d'Etiolles. Etude technique, économique et sociale par la dynamique du débitage, 2 volumes*. Unpublished Doctoral Dissertation (Thèse de 3e cycle), Université de Paris I-Sorbonne.

Pigeot, N. 1986. Apprendre à débiter des lames : un cas d'éducation technique chez les Magdaléniens d'Étiolles. *Bulletin de la Société préhistorique française* 83: 67-69.

Pigeot, N. 1987. *Magdaléniens d'Etiolles. Économie de débitage et organisation sociale*. Paris: Éditions du C.N.R.S.

Pigeot, N. 1988a. Apprendre à debiter des lames : un cas d'education technique chez les Magdaleniens d'Etiolles. In: J. Tixier (ed.), *Technologie préhistorique*, pp. 63-72. Paris: Éditions du C.N.R.S.

Pigeot, N. 1988b. Technical and social actors: flintknapping specialists and apprentices at Magdalenian Etiolles. *Archaeological Review from Cambridge* 9(1): 126-141.

Pigeot, N. 1991. Réflexions sur l'histoire technique de l'Homme : de l'évolution cognitive à l'évolution culturelle. *Paléo* 3: 167-200.

Pigeot, N. (ed.) 2004. *Les derniers magdaléniens d'Etiolles : Perspectives culturelles et paléohistoriques*. Paris: Éditions du CRNS.

Pigeot, N. 2005. « Les valeurs sociales ont varié au cours du Magdalénien ». Conversation between Nicole Pigeot and Jean Zammit. *La Recherche*, March 2005 [URL = http://www.larecherche.fr/nicole-pigeot-%C2%AB-les-valeurs-sociales-ont-vari%C3%A9-au-cours-du-magdal%C3%A9nien-%C2%BB].

Pigeot, N. 2011. Chaînes Opératoires: Contexte Théorique et Potentiel Cognitif. In : R. Treuil (ed.), *L'archéologie Cognitive*, pp. 149-171. Paris: Éditions de la Maison des Sciences de l'Homme (Cogniprisme).

Ploux, S. 1989. Approche Archéologique de La Variabilité des Comportements Techniques Individuels: L'exemple

Pigeot, N., M. Phillipe, G. Le Licon, M. Morgenstern 1991. Systèmes techniques et essai de technologie culturelle à Étiolles : nouvelles perspectives. In: C. Perlès (ed.), *25 Ans d'étude technologique en préhistoire. Bilan et perspectives*, pp. 169-186. Juan-les-Pins: Éditions APDCA.

Pitt, J.C. 2001. The dilemma of case studies: Toward a heraclitian philosophy of science. *Perspectives on Science* 9(4): 373-382.

Ploux, S. 1983. *Étude de débitages expérimentaux : la marque du tailleur*. Publications du l'URA 28, Préhistoire et Technologie, Cahier 2: 109-179.

Ploux, S. 1988. *Approche archéologique de la variabilité des comportements individuels. L'exemple de quelques tailleurs magdaléniens à Pincevent*. Unpublished Doctoral Dissertation, Université de Nanterre – Paris X.

Ploux, S. 1991. Technologie, technicité, techniciens : méthode de détermination d'auteur et comportements techniques individuels. In: C. Perlès (ed.), *25 Ans d'étude technologique en préhistoire. Bilan et perspectives*, pp. 201-214. Juan-les-Pins: Éditions APDCA.

Ploux, S., S. Soriano 2003. Umm el Tlel, une séquence du Paléolithique supérieur en Syrie centrale. Industries lithiques et chronologie culturelle. Paléorient 29(2): 5-34.

Ploux, S., C. Karlin 2014. La gestion d'un savoir-faire, le débitage. In: M. Julien, C. Karlin (eds.), *Un automne à Pincevent. Le campement magdalénien du niveau IV20*, pp. 113-134. Paris: Société préhistorique française.

Ploux, S., C. Karlin, P. Bodu 1991. D'une chaîne à l'autre : normes et variations dans le débitage laminaire magdalénien. *Techniques & Culture* 77-78: 87-114.

Plummer, T. 2004. Flaked Stones and Old Bones: Biological and Cultural Evolution at the Dawn of Technology. *Yearbook of Physical Anthropology* 47: 118-164.

Plummer, T., C.B. Stanford 2000. Analysis of a bone assemblage made by chimpanzees at Gombe National Park, Tanzania. *Journal of Human Evolution* 39: 345-465.

Plutniak, S. 2015. Refrain from Standards? French, Cavemen and Computers: A (short) Story of Multidimensional Analysis in French Prehistoric Archaeology. In: O. Schlaudt, L. Huber (eds.), *Standardization in Measurement: Philosophical, Historical and Sociological Issues*, pp. 39-52. London: Routledge Chapman Hall.

Plutniak, S. 2016. Interests on the margins of the discipline: computing, engineers and archaeologists in France (1950-2000). In: G. Delley, M. Díaz-Andreu, F. Djindjian, V.M. Fernández, A. Guidi, M-A. Kaeser (eds.), *History of Archaeology: International Perspectives*, pp. 221-232. Oxford: Archaeopress.

Plutniak, S., M. Tarantino 2016. An influential outsider. Georges Laplace between French institutions and Italian prehistory. In: G. Delley, M. Díaz-Andreu, F. Djindjian, V.M. Fernández, A. Guidi, M-A. Kaeser (eds.), *History of Archaeology: International Perspectives*, pp. 79-89. Oxford: Archaeopress.

Pobiner, B. L., R.J. Blumenschine 2003. A taphonomic perspective on Oldowan hominid encroachment on the carnivoran paleoguild. *Journal of Taphonomy* 1: 115-141.

Pobiner, B.L., D.R. Braun 2005 Applying actualism: considerations for future research. *Journal of Taphonomy* 3: 57-65.

Pobiner, B.L., J. DeSilva, W.J. Sanders, J.C. Mitani 2007. Taphonomic analysis of skeletal remains from chimpanzee hunts at Ngogo, Kibale National Park, Uganda. *Journal of Human Evolution* 52: 614-636.

Polanyi, K. 2001 [1944]. *The Great Transformation: The Political and Economic Origins of our Time*. Boston (MA): Beacon.

Pope, M., K. Russel, K. Watson 2006. Biface form and structured behaviour in the Acheulean. *Lithics: The Journal of the Lithic Studies Society* 27: 44-57.

Popescu, G.M. 2015. *Late Pleistocene Hunter-Gatherer Settlement and Ecology of the Romanian Carpathians and Adjacent Areas*. Unpublished Doctiral Dissertation, Arizona State University.

Popper, K.1945. *The Open Society and Its Enemies*. London: Routledge.

Popper, K. 1965. *The Logic of Scientific Discovery*. New York (NY): Harper & Row.

Popper, K. 1968. *Conjectures and Refutations*. New York (NY): Harper & Row.

Porter, T. 1986. *The Rise of Statistical Thinking: 1820-1900*. Princeton (NJ): Princeton University Press.

Poston, T., K. McCain (eds.) 2017. *Best Explanations: New Essays on Inference to the Best Explanation*. Oxford: Oxford University Press.

Potts, R. 1982. *Lower Pleistocene Site Formation and Hominid Activities at Olduvai Gorge, Tanzania*. Unpublished Doctoral Dissertation, Harvard University.

Potts, R. 1988. *Early Hominid Activities at Olduvai*. New York: Aldine.

Potts, R. 1991. Why the Oldowan? Plio-Pleistocene toolmaking and the transport of resources. *Journal of Anthropological Research* 47(2): 153-176.

Potts, R. 1996a. Evolution and climate variability. *Science* 273: 922-923.

Potts, R. 1996b. *Humanity's Descent: The Consequences of Ecological Instability*. New York: William Morrow & Co.

Potts, R. 1998. Variability Selection in Hominid Evolution. *Evolutionary Anthropology* 7: 81-96.

Potts, R. 2007. Environmental hypotheses of Pliocene human evolution. In: R. Bobe, Z. Alemseged, A.K. Behrensmeyer (eds.), *Hominin Environments in the East African Pliocene: an Assessment of the Faunal Evidence*, pp. 25-50. New York: Springer.

Potts, R. 2012a. Evolution and Environmental Change in Early Human Prehistory. *Annual Review of Anthropology* 41: 151-167.

Potts, R. 2012b. Environmental and Behavioral Evidence Pertaining to the Evolution of Early Homo. *Current Anthropology* 53(6): 299-317.

Potts, R. 2013. Hominin evolution in settings of strong environmental variability. *Quaternary Science Reviews* 73: 1-13.

Potts, R., C. Sloan 2010. *What Does It Mean To Be Human?* Washington D.C.: National Geographic.

Powell, A., S. Shennan, M.G. Thomas 2009. Late Pleistocene demography and the appearance of modern human behavior. *Science* 324: 1298-1301.

Premo, L.S., G.B. Tostevin 2016. Cultural Transmission on the Taskscape: Exploring the Effects of Taskscape Visibility on Cultural Diversity. *PLoS ONE* 11(9): e0161766.

Pritchard, D. 2015. Anti-luck epistemology and the Gettier problem. *Philosophical Studies* 172(1): 93-111.

Putnam, H. 1967. Psychological Predicates. In: W.H. Capitan, D.D. Merrill (eds.), *Art, Mind, and Religion*, pp. 37-48. Pittsburgh: University of Pittsburgh Press.

Putnam, H. 1981. *Reason, Truth and History*. Cambridge: Cambridge University Press.

Putnam, H. 1987. Truth and Convention. In: J. Conant (ed.) 1990, *Realism with a Human Face*, pp. 96-104. Cambridge (MA): Harvard University Press.

Putnam, H. 1988. *Representation and Reality*. Cambridge (MA): The MIT Press.

Putnam, H. 1994. The Question of Realism. In: J. Conant (ed.), *Words and Life*, pp. 295-312. Cambridge (MA): Harvard University Press.

Putnam, H. 2001. Reply to Jennifer Case. *Revue internationale de philosophie* 218: 431-438.

Queiroz, J., F. Merrell (eds.) 2005. Abduction – between subjectivity and objectivity. *Semiotica* 153 (1/4).

Quine, W.V. 1951a. Main Trends in Recent Philosophy: Two Dogmas of Empiricism. *The Philosophical Review* 60(1): 20-43.

Quine, W.V. 1951b. *Pursuit of truth*. Cambridge (MA): Harvard University Press.

Quine, W.V. 1975. On empirically equivalent systems of the world. *Erkenntnis* 9: 313-328.

Quine, W.V. 1960. *Word and Object*. Cambridge (MA): MIT Press.

Quine, W.V., J.S. Ullian [1970] 1978. *The Web of Belief*. New York: Random House.

Quinet, É. 1990. *La planification française*. Paris: PUF.

Raab, L.M., A.C. Goodyear 1984. Middle-Range Theory in Archaeology: A Critical Review of Origins and Applications. *American Antiquity* 49: 255-268.

Rabardel, P. 1995. *Les Hommes et les technologies. Approche cognitive des instruments contemporains*. Paris: Armand Colin.

Ramírez Galicia, A. 2016. *Faire de la préhistoire « sur le tas » : Quelques notes sur l'histoire intellectuelle de l'ethnologie et de la technologie préhistoriques françaises contemporaines*. Unpublished manuscript.

Rasse, M. 2010. *Espace et temps des premières sociétés, pour une approche des sociétés de la préhistoire par l'espace*. Unpublished Habilitation, Université de Rouen.

Rapkin, B.D., D.A. Luke 1993. Cluster Analysis in Community Research: Epistemology and Practice. *American Journal of Community Psychology* 21(2): 247-277.

Read, D. 2008. An Interaction Model for Resource Implement Complexity Based on Risk and Number of Annual Moves. *American Antiquity* 73: 599-625.

Reck, A.J. 1982. Pepper and Recent Metaphilosophy. *The Journal of Mind and Behavior* 3(3): 207-216.

Reichenbach, H. 1938. *Experience and Prediction. An Analysis of the Foundations and the Structure of Knowledge*. Chicago: University of Chicago Press.

Reid, J.J. 1980. Book review of Analytical Archaeologist. Norman Hammond et al. eds. New York: Academic Press. *American Anthropologist* 82: 878-879.

Reif, W.-E. 1986. The Search for a Macroevolutionary Theory in German Paleontology. *Journal of the History of Biology* 19(1): 79-130.

Renard, C. 2010. *Les premières expressions du Solutréen dans le Sud-Ouest français. Evolution techno-économique des équipements lithiques au cours du Dernier Maximum Glaciaire*. BAR International Series 2070. Oxford: Archaeopress.

Renard, C., J.-M. Geneste 2006. De la « complexité » des productions lithiques dans le Solutréen supérieur d'Aquitaine. In: L. Astruc, F. Bon, V. Léa, P.-Y. Milcent, S. Philibert (eds.), *Normes techniques et pratiques sociales: de la simplicité des outillages pré- et protohistoriques*, pp. 119-128. Antibes: APDCA.

Renard, C., S. Ducasse 2015. De la rupture typologique à la fracture socio-économique. Implications sur les systèmes de mobilité entre Solutréen récent et Badegoulien dans le Sud-Ouest français (24-21 ka cal. BP). In: N. Naudinot, L. Meignen, D. Binder, G. Querré (eds.), *Les systèmes de mobilité de la Préhistoire au Moyen Âge*, pp. 193-208. Antibes: Éditions APDCA.

Renfrew, C. 1969. Trade and culture process in European prehistory. *Current Anthropology* 10: 151-169.

Renfrew, C., P. Bahn 2012 [1991]. *Archaeology: Theories, Methods, and Practice*. 6th Edition. New York: Thames & Hudson.

Reti, J.S. 2016. Quantifying Oldowan Stone Tool Production at Olduvai Gorge, Tanzania. *PLoS ONE*11(1): e0147352.

Révillion, S. 1993. Question typologique à propos des industries laminaires du paléolithique moyen de Seclin (Nord) et de Saint-Germain-des-Vaux/Port-Racine (Manche) : lames levallois ou lames non levallois ?. *Bulletin de la société préhistorique française* 90(4): 269-274.

Révlillion, S. 1994. *Les industries laminaires du Paléolithique moyen en Europe septentrionale. L'exemple des gisements de Saint-Germain-des-Vaux/Port-Racine (Manche), de Seclin (Nord) et de Riencourt-les-Bapaume (Pas-de-Calais).* Lille: Publications du CERP.

Rezek, Z., S. Lin, R. Iovita, H.L. Dibble 2011. The relative effects of core surface morphology on flake shape and other attributes. *Journal of Archaeological Science* 38(6): 1346-1359.

Rezek, Z., S.C. Lin, H.L. Dibble 2016. The Role of Controlled Experiments in Understanding Variation in Flake Production. In: A. Sullivan III., D.I. Olszewski (eds.), *Archaeological Variability and Interpretation in Global Perspective*, pp. 307-320. Boulder: University of Colorado Press.

Rezek, Z., H.L. Dibble, S.P. McPherron, D.R. Braun, S.C. Lin 2018. Two million years of flaking stone and the evolutionary efficiency of stone tool technology. *Nature Ecology & Evolution* 2: 628-633.

Rheinberger, H.-J. 1992. *Experiment, Differenz, Schrift. Anmerkungen zur Geschichte epistemischer Dinge*. Marburg: Basiliskenpresse.

Richard, N. 1992. *L'invention de la préhistoire. Une anthologie*. Paris: Presses Pocket, « Agora ».

Richerson, P.J., R. Boyd 2005. *Not By Genes Alone: How Culture Transformed Human Evolution*. Chicago: University of Chicago Press.

Richter, J. 2018. *Altsteinzeit. Der Weg des frühen Menschen von Afrika bis in die Mitte Europas*. Stuttgart: Kohlhammer.

Ricoeur, P. [1955] 1965. *History and Truth*. Translated by C.A. Kelbley. Evanston: Northwestern University Press.

Ricoeur, P. [2000] 2004. *Memory, History, Forgetting*. Translated by. K. Blamey and D, Pellauer, Chicago: University of Chicago Press.

Riel-Salvatore, J. 2010. A Niche Construction Perspective on the Middle-Upper Paleolithic Transition in Italy. *Journal of Archaeological Method and Theory* 17(4): 323-355.

Riel-Salvatore, J., C.M. Barton 2004. Late Pleistocene Technology, Economic Behavior, and Land-Use Dynamics in Southern Italy. *American Antiquity* 69(2): 257-274.

Riel-Salvatore, J., G. Popescu, C.M. Barton 2008. Standing at the gates of Europe: Human behavior and biogeography in the Southern Carpathians during the Late Pleistocene. *Journal of Anthropological Archaeology* 27(4): 399-417.

Rigaud, J.-P. 1978. The Significance of Variability Among Lithic Artifacts: A Specific Case from Southwestern France. *Journal of Anthropological Research* 34(3): 299-310.

Robbins, L. 1932. *An essay on the nature and significance of economics*. London: Macmillan and Co.

Roberts, P. 2016. 'We have never been behaviourally modern': The implications of Material Engagement Theory and Metaplasticity for understanding the Late Pleistocene record of human behaviour. *Quaternary International* 40A: 8-20.

Roberts, P. 2017. Forests of plenty: Ethnographic and archaeological rainforests as hotspots of human activity. *Quaternary International* 448: 1-4.

Roberts, P., N. Boivin, M.D. Petraglia 2015. The Sri Lankan 'Microlithic' Tradition c. 38,000 to 3,000 Years Ago: Tropical Technologies and Adaptations of Homo sapiens at the Southern Edge of Asia. *Journal of World Prehistory* 28: 69-112.

Roberts, P., N. Boivin, J. Lee-Thorp, M.D. Petraglia, J. Stock 2016. Tropical Forests and the Genus Homo. *Evolutionary Anthropology* 25: 306-317.

Robertson, T., P. Atkins 2018. Essential vs. Accidental Properties. In: E.N. Zalta (ed.), *The Stanford Encyclopedia of Philosophy* (Spring 2018 Edition): URL = https://plato.stanford.edu/archives/spr2018/entries/essential-accidental/ [last accessed 16.07.2018].

Robinson, E., F. Sellet (eds.) 2018. *Lithic Technological Organization and Paleoenvironmental Change. Global and Diachronic Perspectives*. New York: Springer.

Rocca, R. 2013. *Peut-on définir des aires culturelles au Paléolithique inférieur ? Originalité des premières industries lithiques en Europe centrale dans le cadre du peuplement de l'Europ*e. Unpublished Doctoral Dissertation, Université de Paris X-Nanterre.

Roche, H., J. Tixier 1982. Les accidents de taille. *Studia præhistorica belgica* 2: 65-76.

Roche, H., J.-P. Texier 1991. La notion de complexité dans un ensemble lithique. Application aux séries acheuléennes d'Isenya (Kenya). In: C. Perlès (ed.), *25 Ans d'étude technologique en préhistoire. Bilan et perspectives*, pp. 99-108. Juan-les-Pins: Éditions APDCA.

Rodriguez-Pereyra, G. 2016. Nominalism in Metaphysics. In: E.N. Zalta (ed.), *The Stanford Encyclopedia of Philosophy*. URL = https://plato.stanford.edu/archives/win2016/entries/nominalism-metaphysics [last accessed 13.02.2018].

Roe, D.A. 1968. British Lower and Middle Palaeolithic handaxe groups. *Proceedings of the Prehistoric Society* 34: 1-82

Roebroeks, W., R.H.A. Corbey 2001. Biases and double standards in palaeoanthropology. In: R. Corbey, W. Roebroeks (eds.), *Studying Human Origins. Disciplinary History and Epistemology*, pp. 67-76. Amsterdam: Amsterdam University Press.

Rolland, N. 1977. New Aspects of Middle Paleolithic Variability in Western Europe. *Nature* 255: 251-252.

Rolland, N. 1981. The Interpretation of Middle Paleolithic Variability. *Man* 16: 15-42.

Rolland, N., H. Dibble 1990. A New Synthesis of Middle Paleolithic Variability. *American Antiquity* 55(3): 480-499.

Romanowska, I. 2015. Agent-based Modelling and Archaeological Hypothesis Testing: the Case Study of the European Lower Palaeolithic. In: A. Traviglia (ed.), *Across Space and Time*, pp. 203-214. Amsterdam: Amsterdam University Press.

Rorty, R. (ed.) 1967. *The Linguistic Turn: Recent Essays in Philosophical Method*. Chicago: University of Chicago Press.

Rorty, R. 1998. *Truth and Progress*. Cambridge: Cambridge University Press.

Rossignol, J. 1992. Concepts, Methods, and Theory Building: A Landscape Approach. In: J. Rossignol, L. Wandsnider (eds.), *Space, Time, and Archaeological Landscapes*, pp. 3-19. New York: Springer.

Roth, B.J., H.L. Dibble 1998. Production and transport of blanks and tools at the French Middle Paleolithic site of Combe-Capelle bas. *American Antiquity* 63: 47-62.

Roussel, M. 2011. *Normes et variations de la production lithique durant le Châtelperronien: la séquence de la Grande-Roche-de-la-Plématrie à Quinçay (Vienne)*. Unpublished Doctoral Dissertation, Université de Paris X-Nanterre.

Roussel, M. 2013. Méthodes et rythmes de débitage au Châtelperronien: comparaison avec le Protoaurignacien. *Comptes Rendus Palevol* 12(4): 233-241.

Roux, V. 2013. Ethnoarchaeology in France: Trends and Perspectives. In: A. Marciniak, N. Yalman (eds.), *Contesting Ethnoarchaeologies: Traditions, Theories, Prospects*, pp. 17-34. New York: Springer.

Ruebens, K. 2012. *From Keilmesser to Bout Coupé Handaxes: Macro-Regional Variability among Western European Late Middle Palaeolithic Bifacial Tools*. Unpublished Doctoral Dissertation, University of Southampton.

Ruebens, K. 2014. Late Middle Palaeolithic bifacial technologies across northwest Europe: Typo-technological variability and trends. *Quaternary International* 350: 130-146.

Ruebens, K, R.M. Wragg Sykes 2016. Spatio-temporal variation in late Middle Palaeolithic Neanderthal behaviour: British bout coupé handaxes as a case study. *Quaternary International* 411(Part A): 305-326.

Russell, B. 1971 [1912]. *Problems of Philosophy*. Oxford: Oxford University Press.

Sabloff, J.A., G.R. Willey 1967. The Collapse of Maya Civilization in the Southern Lowlands: a Con- sideration of History and Process. *Southwestern Journal of Anthropology* 23: 311-336.

Sackett, J.R. 1966. Quantitative analysis of Upper Paleolithic stone tools. *American Anthropologist* 68(2): 356-394.

Sackett, J.R. 1973. Style, function and artifact variability in Paleolithic assemblages. In: C. Renfrew (ed.), *The explanation of culture change*, pp. 317-325. London: Duckworth.

Sackett, J.R. 1982. Approaches to style in lithic archaeology. *Journal of Anthropological Archaeology* 1(1): 59-112.

Sackett, J.R. 1986. Style, Function, and Assemblage Variability: A Reply to Binford. *American Antiquity* 51(3): 628-634.

Sackett, J.R. 1991. Straight Archaeology French Style: The Phylogenetic Paradigm in Historic Perspective. In: G.A. Clark (ed.), *Perspectives on the Past: Theoretical Biases in Mediterranean Hunter-Gatherer Research*, pp. 109-139. Philadelphia: University of Pennsylvania Press.

Sackett, J.R. 1999. *The archaeology of Solvieux: an Upper Paleolithic open air site in France*. Los Angeles: Monumenta Archaeologica 19.

Sackett, J.R. 2014. François Bordes and the Old Stone Age. *Bulletin of the History of Archaeology* 24(3): 1-9.

Sahlins, M. 1972. *Stone Age Economics*. New York: Aldine de Gruyter.

Salmon, W.C. 1967. *Foundations of Scientific Inference*. Pittsburgh (PA): University of Pittsburgh Press.

Salmon, W. 1984. *Scientific Explanation and the Causal Structure of the World*. Princeton: Princeton University Press.

Sandgathe, D.M. 2004. An Alternative Interpretation of the Levallois Reduction Technique. *Lithic Technology* 29(2): 147-159.

Sartre, J.-P. 1960. *Critique de la raison dialectique*. Paris: Éditions Gallimard.

Scarre, C. 1999. Archaeological theory in France and Britain. *Antiquity* 73: 155-161.

Scerri, E.M.L., H.S. Groucutt, R.P. Jennings, M.D. Petraglia 2014. Unexpected technological heterogeneity in northern Arabia indicates complex Late Pleistocene demography at the gateway to Asia. *Journal of Human Evolution* 75: 125-142.

Scerri, E.M.L., B. Gravina, J. Blinkhorn, A. Delagnes 2016. Can Lithic Attribute Analyses Identify Discrete Reduction Trajectories? A Quantitative Study Using Refitted Lithic Sets. *Journal of Archaeological Method and Theory* 23(2): 669-691.

Scerri, E.M.L., M.G. Thomas, A. Manica, P. Gunz, J.T. Stock, C. Stringer, M. Grove, H.S. Groucutt, A. Timmermann, G.P. Rightmire, F. d'Errico, C.A. Tryon, N.A. Drake, A.S. Brooks, R.W. Dennell, R. Durbin, B.M. Henn, J. Lee-Thorp, P. deMenocal, M.D. Petraglia, J.C. Thompson, A. Scally, L. Chikhi 2018. Did Our Species Evolve in Subdivided Populations across Africa, and Why Does It Matter? *Trends in Ecology & Evolution* 2399: DOI: https://doi.org/10.1016/j.tree.2018.05.005.

Schick, J.F.M. 2013. Die Erfindung der Offenheit. Kreatives Handeln im Ausgang von Gilbert Simondon. In: J.F.M Schick, R.H. Ziegler (eds.), Die innere Logik der Kreativität, pp. 153-179. Würzburg: Königshausen & Neumann.

Schick, J.F.M. 2018. Vom homo faber zum homo coordinans: Intuition, Technik und Erfindung bei Gilbert Simondon. In: D. Magnus, S. Rickenbacher (eds.), T*echnik-Ereignis-Material. Neue Perspektiven auf Ontologie, Aisthesis und Ethik der stofflichen Welt*, in press. Berlin: Kadmos.

Schick, K.D. 1986. *Stone Age Sites in the Making: Experiments in the Formation and Transformation of Archaeological Occurrences*. BAR International Series 314. Oxford: Archaeopress.

Schick, K.D. 1987. Modeling the formation of Early Stone Age artifact concentrations. *Journal of Human Evolution* 16(7-8): 789-807.

Schick, K.D. 1997. Experimental Studies of Site-Formation Processes. In: G.L. Isaac, B. Isaac (eds.), *Koobi Fora Research Project, Volume 5: Plio-Pleistocene Archaeology*, pp. 244-256. Oxford: Oxford University Press.

Schick, K.D., N. Toth 1993. *Making Silent Stones Speak: Human Evolution and the Dawn of Technology*. New York: Simon and Schuster.

Schick, K.D., N. Toth 2001. Paleoanthropology at the Millennium. In: G.M. Feinman, T.D. Price (eds.), *Archaeology at the Millennium: A Sourcebook*, pp. 39-108. New York: Springer.

Schiffer, M.B. 1972. Archaeological Context and Systemic Context. *American Antiquity* 37(2): 156-165.

Schiffer, M.B. 1976. *Behavioral Archeology*. New York: Academic Press.

Schiffer, M.B. 1983. Toward the Identification of Formation Processes. *American Antiquity* 48(4): 675-706.

Schiffer, M.B. 1988. The Structure of Archaeological Theory. *American Antiquity* 53: 461-485.

Schindewolf, O.H. 1950. *Grundfragen der Paläontologie*. Stuttgart: Schweizerbart' sche Verlagsbuchhandlung.

Schiwy, G. 2006. Nachwort: Teilhard de Chardins « Entstehung des Menschen » zwischen Kreationismus, Existentialismus und Evolutionismus. In: P. Teilhard de Chardin, *Die Entstehung des Menschen*, pp. 131-139. Translated by G. Scheel. Munich: C.H. Beck.

Schlanger, N. 1990. Techniques as human action – two perspectives. *Archaeological Review from Cambridge* 9(1): 18-26.

Schlanger, N. 1991. Le fait technique total. La raison pratique et les raisons de la pratique dans l'œuvre de Marcel Mauss. *Terrain* 16: 114-130.

Schlanger, N. 1994. Mindful technology: unleashing the *chaîne opératoire* for an archaeology of mind. In: C. Renfrew, E.B.W. Zubrow (eds.), *The Ancient Mind: Elements of a Cognitive Archaeology*, pp. 143-151. Cambridge: Cambridge University Press.

Schlanger, N. 2004. « Suivre les gestes, éclat par éclat » – la chaîne opératoire d'André Leroi-Gourhan. In: Audouze, F., N. Schlanger (eds.), *Autour de l'homme. Contexte et actualité d'André Leroi-Gourha*n, pp. 5-25. Antibes: Éditions APDCA.

Schlanger, N. 2005. The Chaîne Opératoire. In: C. Renfrew, P. Bahn (eds.), *Archaeology: the key concepts*, pp. 25-31. London: Routledge.

Schlanger, N. 2012. Une technologie engagé : Marcel Mauss et l'étude des techniques dans les sciences sociales. In: N. Schlanger (ed.), *Marcel Mauss. Techniques, technologie et civilisation*, pp. 17-134. Paris: Quadrige.

Schlanger, N. 2015. L'insaisissable technologie d'André Leroi-Gourhan. Des tendances et des faits des années 1930 à l'après-guerre. In: P. Soulier (ed.), *André Leroi-Gourhan, « l'homme simplement »*, pp. 103-116. Paris: Éditions de Boccard.

Schlick, M. 1932/33. Positivism and Realism. *Erkenntnis* 3: 1-31 (in German). Translated by Peter Heath and reprinted in: R. Boyd, P. Gasper, J.D. Trout (eds.) 1991, *The Philosophy of Science*. Cambridge (MA): MIT Press.

Schlick, M. 1959. The Foundation of Knowledge. In: A.J. Ayer (ed.), *Logical Positivism*, pp. 209-227. New York: Free Press.

Schmider, B. 1971. *Les industries lithiques du Paléolithique supérieur en Ile-de-France*. Paris: Éditions CNRS.

Schmider, B. 1982. The Magdalenian Culture of the Paris River-Basin and Its Relationship with the Nordic Cultures of the Late Old Stone Age. *World Archaeology* 14(2): 259-269

Schmider, B. 1988. Les industries du centre du Bassin parisien au Paléolithique récent : essai de chronologie. In: M. Otte (ed.), *De la Loire à l'Oder : les civilisations du Paléolithique final dans le nord-ouest européen, volume 1*, pp. 1-12. Oxford/Liège: BAR International Series/ERAUL.

Schmider, B., A. Roblin-Jouve 2008. *Le Massif de Fontainebleau au Paléolithique supérieur : les grands sites d'habitat – Évolution des cultures et des paysages*. Liège: ERAUL 120.

Schnapp, A. 1980. *L'archéologie aujourd'hui*. Paris: Hachette.

Schnapp, A. 1993. *The Discovery of the Past*. Translated by I.A. Kinnes, G. Varndell. London: British Museum Press.

Schneider, H.K. 1964. A Model of African Indigenous Economy and Society. *Comparative Studies in Society and History VII*: 35-55.

Schneider, H.K. 1974. *Economic Man*. New York: Free Press.

Scholl, R., T. Rätz 2016. Towards a Methodology for Integrated History and Philosophy of Science. In: T. Sauer, R. Scholl (eds.), *The Philosophy of Historical Case Studies*, pp. 69-91. Basel: Springer.

Schuh, R.T. 2000. *Biological systematics: principles and applications*. Ithaca (NY): Cornell University Press.

Schurz, G. (ed.) 1988. *Erklären und Verstehen in der Wissenschaft*. München: Verlag Oldenbourg.

Schurz, G. 1999. Explanation as Unification. *Synthese* 120(1): 95-114.

Schurz, G. 2011. *Evolution in Natur und Kultur. Eine Einführung in die verallgemeinerte Evolutionstheorie*. Heidelberg: Spektrum.

Schurz, G., M. Carrier (eds.) 2013. *Werte in den Wissenschaften. Neue Ansätze zum Werturteilsstreit*. Frankfurt a. Main: Suhrkamp.

Scott, B. 2011. *Becoming Neanderthals: The earlier British middle Palaeolithic*. Oxford: Oxbow Books.

Scruton, R. 1985. *Thinkers of the New Left*. Harrow: Longman.

Scruton, R. 1997. *The Aesthetics of Music*. Oxford: Oxford University Press

Scruton, R. 2007. Thoughts on Rhythm. In: K. Stock (ed.), *Philosophers on Music: Experience, Meaning, and Work*, pp. 226-255. Oxford: Oxford University Press.

Sellet, F. 1993. Chaîne Opératoire. The Concept and Its Applications. *Lithic Technology* 18(1-2): 106-112.

Sellet, F. 1995. Levallois or Not Levallois? Does it Really Matter? Learning from an African Case. In: H.L. Dibble, O. Bar-Yosef (eds.), *The Definition and Interpretation of Levallois Technology*, pp. 25-39. Madison: Prehistory Press.

Sept, J., D. Pilbeam (eds.) 2012. *Casting the Net Wide: Papers in Honor of Glynn Isaac and His Approach to Human Origins Research*. Oxford: Oxbow Books.

Séris, J.-P. 1994. *La technique*. Paris: PUF.

Shadish, W.R., T.D. Cook, D.T. Campbell 2002. *Experimental and Quasi-Experimental Designs for Generalized Causal Inference*. Boston/New York: Houghton Mifflin Company.

Shanks, M. 1992. *Experiencing the Past. On the character of Archaeology*. London: Routledge.

Shea, J.J. 2003. Neandertals, Competition, and the Origin of Modern Human Behavior in the Levant. *Evolutionary Anthropology* 12: 173-187.

Shea, J.J. 2007. Behavioral differences between Middle and Upper Paleolithic Homo sapiens in the East Mediterranean Levant: the roles of intraspecific competition and dispersal from Africa. *Journal of Anthropological Research* 64: 449-488.

Shea, J.J. 2009. The Impact of Projectile Weaponry on Late Pleistocene Human Evolution. In: J.-J. Hublin, M. Richards (eds.), *The Evolution of Hominid Diets: Integrating approaches to the study of Palaeolithic subsistence*, pp. 1987-197. New York: Springer.

Shea, J.J. 2011a. Stone Tool Analysis and Human Origins Research: Some Advice from Uncle Screwtape. *Evolutionary Anthropology* 20: 48-53.

Shea, J.J. 2011b. Homo sapiens Is as Homo sapiens Was. Behavioral Variability versus "Behavioral Modernity" in Paleolithic Archaeology. *Current Anthropology* 52(1): 1-35.

Shea, J.J. 2011c. Behavioral Modernity – Not Again: A Reply to Porr. *Current Anthropology* 52(4): 583-584.

Shea, J.J. 2013a. *Stone Tools in the Paleolithic and Neolithic Near East. A Guide*. Cambridge: Cambridge University Press.

Shea, J.J. 2013b. Lithic Modes A–I: A New Framework for Describing Global-Scale Variation in Stone Tool Technology Illustrated with Evidence from the East Mediterranean Levant. *Journal of Archaeological Method and Theory* 20(1): 151-186.

Shea, J.J. 2014. Sink the Mousterian? Named stone tool industries (NASTIES) as obstacles to investigating hominin evolutionary relationships in the Later Middle Paleolithic Levant. *Quaternary International* 350: 169-179.

Shea, J.J. 2015. Strategic Modeling in Pleistocene Archeology, Thank You, Irv!. In: J.G. Fleagle, S. Blaffer Hrdy (eds.), Irven DeVore, 1934-2014, pp. 99-100. With contributions by B. Smuts, R. Trivers, R. Wrangham, R.A. Mittermeier, K.B. Strier and J.J. Shea. *Evolutionary Anthropology* 24: 85-100.

Shea, J.J. 2017a. *Stone Tools in Human Evolution. Behavioral Differences among Technological Primates*. Cambridge: Cambridge University Press.

Shea, J.J. 2017b. Occasional, obligatory, and habitual stone tool use in hominin evolution. *Evolutionary Anthropology* 26: 200-217.

Shea, J.J., J.D. Klenck 1993. An Experimental Investigation of the Effects of Trampling on the Results of Lithic Microwear Analysis. *Journal of Archaeological Science* 20(2): 175-194.

Shea, J.J., D.E. Lieberman (eds.) 2009. *Transitions in Prehistory: Essays in Honor of Ofer Bar-Yosef*. Oxford: Oxbow Books.

Shea, J.J., M.L. Sisk 2010. Complex Projectile Technology and Homo sapiens Dispersal into Western Eurasia. *PaleoAnthropology* 2010: 100-122.

Shelley, C. 1996. Visual Abductive Reasoning in Archaeology. *Philosophy of Science* 63(2): 278-301.

Shennan, S.J. 1993. After social evolution: a new archaeological agenda? In: N. Yoffee, A. Sherratt (eds.), *Archaeological theory: who sets the agenda?*, pp. 53-59. Cambridge: Cambridge University Press.

Shennan, S.J. 1997 [1988]. *Quantifying Archaeology*. Iowa City: University of Iowa Press.

Shennan, S.J. 2001. Demography and cultural innovation: a model and its implications for the emergence of modern human culture. *Cambridge Archaeological Journal* 11(1): 5-16.

Shennan, S.J. 2002. *Genes, Memes and Human History: Darwinian Archaeology and Cultural Evolution*. London: Thames & Hudson.

Shennan, S.J. 2004. Analytical Archaeology. In: J. Bintliff (ed.), *A Companion to Archaeology*, pp. 3-20. Oxford: Blackwell.

Shennan, S.J. 2008. Evolution in Archaeology. *Annual Review of Anthropology* 37: 75-91.

Shennan, S.J. (ed.) 2009. *Pattern and Process in Cultural Evolution*. Berkeley: University of California Press.

Sher, G. 2013. Forms of correspondence: The intricate route from thought to reality. In: N. Pedersen, C.D. Wright (eds.), *Truth and pluralism: current debates*, pp. 157-179. Oxford: Oxford University Press.

Shott, M.J. 1986. Technological organization and settlement mobility: an ethnographic examination. *Journal of Anthropological Research* 42: 15-51.

Shott, M.J. 1998. Status and Role of Formation Theory in Contemporary Archaeological Practice. *Journal of Archaeological Research* 6: 299-330.

Shott, M.J. 2003. Chaîne Opératoire And Reduction Sequence. *Lithic Technology* 28(2): 95-105.

Shott, M.J. 2005a. Two cultures: thought and practice in British and North American archaeology. *World Archaeology* 37(1): 1-10.

Shott, M. J. 2005b. The reduction thesis and its discontents: Review of Australian approaches. In C. Clarkson, L. Lamb (eds.), *Lithics 'Down Under': Australian Perspectives on Lithic Reduction, Use and Classification*, pp. 109-125. Oxford: Archaeopress.

Shott, M.J. 2007. The Role of Reduction Analysis in Lithic Studies. *Lithic Technology* 32(1): 131-141.

Shott, M.J. 2010. Size Dependence in Assemblage Measures: Essentialism, Materialism, and "SHE" Analysis in Archaeology. *American Antiquity* 75(4): 886-906.

Shott, M.J. 2011. History Written in Stone: Evolutionary Analysis of Stone Tools in Archeology. *Evolution: Education and Outreach* 4(3): 435-445.

Shott, M.J. 2014. Digitizing Archaeology: A Subtle Revolution in Analysis. *World Archaeology* 46: 1-9.

Shott, M.J. 2017. Stage and continuum approaches in prehistoric biface production: A North American perspective. *PLoS ONE* 12(3): e0170947.

Shott, M.J., B.W. Trail 2010. Exploring New Approaches to Lithic Analysis: Laser Scanning and Geometric Morphometrics. *Lithic Technology* 35(2): 195-220.

Shott, M.J., G. Tostevin 2015. Diversity under the Bipolar Umbrella. *Lithic Technology* 40(4): 377-384.

Shott, M.J., A.P. Bradbury, P.J. Carr, G.H. Odell 2000. Flake Size from Platform Attributes: Predictive and Empirical Approaches. *Journal of Archaeological Science* 27(10): 877-894.

Shott, M.J., J.M. Lindly, G.A. Clark 2011. Continuous Modeling of Core Reduction: Lessons from Refitting Cores from WHS 623x, an Upper Paleolithic Site in Jordan. *PaleoAnthropology* 2011: 320-333.

Shrader-Frechette, K. 1995. Hard Ecology, Soft Ecology, and Ecosystem Integrity. In: L. Westra, J. Lemons (eds.) *Perspective on Ecological Integrity*, pp 125-145. Dordrecht: Springer.

Sigaut, F. 1978. *Les Réserves de grains à long terme. Techniques de conservation et fonctions sociales dans l'histoire*. Paris: Éditions de la MSH/Publications de l'Université de Lille III.

Sigaut, F. 1991. Un couteau ne sert pas à couper mais en coupant. Structure, fonctionnement et fonction dans l'analyse des objets. In: C. Perlès (ed.), *25 ans d'études technologiques en préhistoire*, pp. 21-34. Juan-les-Pins: APDCA.

Sigaut, F. 1994. Technology. In: T. Ingold (ed.), *Companion Encyclopedia of Anthropology*, pp. 420-459. London/New York: Routledge.

Sigaut, F. 2007. Les outils et le corps. *Communications* 81: 9-30 ['Corps et techniques,' special issue edited by G. Vigarello].

Sigaut, F. 2010. Postface. In : A.-G. Haudricourt (eds.), *Des gestes aux techniques. Essai sur les techniques dans les sociétés prémachinistes*, pp. 217-224. Paris/Versailles: Éditions de la Maison des sciences de l'homme/Éditions Quae.

Sigaut, F. 2012. *Comment* Homo *devint* faber. Paris: CNRS Éditions.

Simondon, G. 1958. *Du mode d'existence des objets techniques*. Paris: Aubier.

Simondon, G. 1964. *L'individu et sa genèse physico-biologique*. Paris: PUF.

Simondon, G. 1989. *L'Individuation psychique et collective à la lumière des notions de Forme, Information, Potentiel et Métastabilité*. Paris: Aubier.

Simondon, G. 2014. *Sur la technique*. Paris: PUF.

Simpson, G.G. 1961. *Principles of animal taxonomy*. New York: Columbia University Press.

Skrbina, D. 2005. *Panpsychism in the West*. Cambridge (MA): The MIT Press.

Skyrms, B. 1980. *Causal Necessity*. New Haven: Yale University Press.

Skyrms, B. 2001. The Stag Hunt. *Proceedings and Addresses of the American Philosophical Association* 75(2): 31-41.

Skyrms, B. 2004. *The Stag Hunt and the Evolution of Social Structure*. Cambridge: Cambridge University Press.

Slice, D.E. 2005. Modern morphometrics. In: D.E. Slice (ed.), *Modern Morphometrics in Physical Anthropology*, pp. 1-45. New York: Kluwer.

Slice, D.E. 2007. Geometric morphometrics. *Annual Review of Anthropology* 36: 261-281.

Slingerland, E. 2008. *What Science Offers the Humanities: Integrating Body & Culture*. Cambridge: Cambridge University Press.

Slingerland, E., M. Collard (eds.) 2012. *Creating Consilience: Integrating the Sciences and the Humanities*. Oxford: Oxford University Press.

Slimak, L. 1998/1999. La variabilité des débitages Discoïdes au Paléolithique Moyen : diversité des méthodes et unité d'un concept. L'exemple des gisements de la Baume Néron (Soyons, Ardèche) et du Champ Grand (Saint-Maurice-sur-Loire, Loire). *Préhistoire Anthropologie Méditerranéennes* 7-8: 75-88.

Slimak, L. 2003. Les débitages Discoïdes moustériens : évaluation d'un concept technologique. In: M. Peresani (ed.), *Discoid lithic technology - Advances and implications*, pp. 33-65. Oxford: Archaeopress.

Slimak, L. 2004. *Les dernières expressions du Moustérien entre Loire et Rhône*. Unpublished Doctoral Dissertations, Université de Provence.

Slimak, L. 2006. L'impossible burin Moustérien. Devenir du burin moustérien, une appartition de la vieille chute de burin et de la petite chose moustérienne. In: M. de Araujo Igreja, J.-P. Bracco, F. Le Brun-Ricalens (eds.), B*urins préhistoriques : formes, fonctionnements, fonctions*, pp. 35-52. Luxembourg: Publications du Musée National d'Histoire et d'Art.

Slimak, L. 2007. Le Néronien et la structure historique du basculement du Paléolithique moyen au Paléolithique supérieur en France méditerranéenne. *Comptes Rendus Palevol* 6 (4): 301-309

Slimak, L. 2010. Droit de réponse au compte-rendu de Sylvain Soriano. *Bulletin de la Société préhistorique française* 107(3): 603-604.

Smith, D.W. 2013. Temporality and Truth. *Deleuze Studies* 7(3): 377-389.

Smith, P.E.L 1966. *Le Soluréen en France*. Bordeaux: Delmas.

Snow, C.P. 1998 [1959]. *The Two Cultures*. With an Introduction by S. Collini. Cambridge: Cambridge University Press.

Staddon, J.E.R. 1993. Pepper with a Pinch of Psalt. The Behavior Analyst 16: 245-250.

Steele, J. 1994. Communication networks and dispersal patterns in human evolution: a simple simulation model. *World Archaeology* 26(2): 126-143.

Steele, J. 1996. On predicting hominid group sizes. In: J. Steele, S. Shennan (eds.), *The Archaeology of Human Ancestry: Power, Sex and Tradition*, pp. 207-229. London: Routledge.

Stengers, I. 1988. *Entre le temps et l'éternité*. Paris: Fayard.

Stengers, I. 2003 [1997]. *Cosmopolitiques*. Paris: La Découverte.

Stern, N. 1993. The structure of the Lower Pleistocene archaeological record: a case study from the Koobi Fora Formation in northwest Kenya. Current Anthropology 34: 201-225.

Stern, N. 2008. Time Averaging and the Structure of Late Pleistocene Achaeological Deposits in South West Tasmania. In: S. Holdaway, L. Wandsnider (eds.), Time in Archaeology: Time Perspectivism Revisited, pp. 134-148. Salt Lake City: University of Utah Press.

Steward, J.H. 1937. Ecological aspects of southwestern society. *Anthropos* 32: 87-104.

Steward, J.H. 1955. *Theory of Culture Change: The Methodology of Multilinear Evolution*. Urbana: University of Illinois Press.

Steward, J.H. 1968. Cultural ecology. In: D.L. Sills (ed.), *International Encyclopedia of the Social Sciences, Vol. 4*, pp. 337-344. New York: Macmillan.

Stiegler, B. 1994. *La Technique et le temps, 1: La Faute d'Épiméthée*. Paris: Galilée.

[Stiegler, B. 2009. *Technik und Zeit. Der Fehler des Epimetheus*. Zürich/Berlin: Diaphanes.]

Stiegler, B. 1998. Temps et individuations technique, psychique et collective dans l'œuvre de Simondon. *Intellectica, Sciences sociales et cognition* 1-2(26-27): 241-256.

Stiegler, B. 2003. Allgemeine Organologie und positive Pharmakologie (Theorie und ›praxis‹). Translated from French into German by Ksymena Wojtyczka. In: E. Hörl (ed.), *Die technologische Bedingung. Beiträge zur Beschreibung der technischen Welt*, pp. 110-146. Frankfurt a. Main: Suhrkamp.

Stiegler, B. 2004a. André Leroi-Gourhan et la raison technologique. L'épiphylogenèse. In: F. Audouze, N. Schlanger (eds.), *Autour de l'homme. Contexte et actualité d'André Leroi-Gourhan*, pp. 69-92. Antibes: Éditions APDCA.

Stiegler, B. 2004b. *Philosopher par accident : Entretiens avec Elie During*. Paris: Galilée.

Stiegler, B. 2005. *Manifesto of Ars Industrialis. In: The Re-enchantment of the World*. Unpublished Manuscript [http://www.arsindustrialis.org/manifeste2005].

Stiegler, B. 2006. *Mécréance et discrédit, vol III: L'esprit perdu du capitalisme*. Paris: Galilée.

Stiegler, B. 2010. *Ce qui fait que la vie vaut la peine d'être vécue : De la pharmacologie*. Paris: Flammarion.

Stoczkowski, W. 1990. Anthropologie naïve et visions savants du milieu naturel des premiers hominidés. *Annales de la Fondation Fyssen* 5-6: 23-34.

Stoczkowski, W. 1991. De l'origine de la division sexuelle du travail : quelques fossiles vivants de l'imaginaire. *Les Nouvelles de l'Archéologie* 44: 15-19.

Stoczkowski, W. 1992a. Origines de l'homme: Quand la science répète le myth. *La Recherche* 23: 746-750.

Stoczkowski, W. 1992b. Préhistoire, ethnologie, et approche prédictive : les tentations d'une épistémolgie spontanée. In: A. Gallay, F. Audouze, V. Roux (eds.), *Ethnoarchéologie. Justification, problèmes, limites*, pp. 33-34. Juan-les-Pins: APDCA.

Stoczkowski, W. 1994. *Anthropologie naïve, anthropologie savante. De l'origine de l'homme, de l'imagination et des idées reçues*. Paris: CNRS.

Stoczkowski, W. 1995. Le bipède et sa science. L'histoire d'une structure de la pensée naturaliste. *Gradhiva, revue d'histoire et d'archives de l'anthropologie* 17: 16-43.

Stoczkowski, W. 2002. *Explaining Human Origins. Myth, Imagination and Conjecture*. Cambridge: Cambridge University Press.

Stutz, A.J., L. Nilsson Stutz 2017. Mughr el-Hamamah. An Early Upper Palaeolithic Cave Site on the Eastern Jordan Valley Flanks. In: Y. Enzel, O. Bar-Yosef (eds.), *Quaternary of the Levant: Environments, Climate Change, and Humans*, pp. 285-290. Cambridge: Cambridge University Press.

Sober, E. 1988. *Reconstructing the Past: Parsimony, Evolution, and Inference*. Cambridge (MA): MIT Press.

Sober, E. 2006. Evolution, Population Thinking, and Essentialism. In: E. Sober (ed.), *Conceptual Issues in Evolutionary Biology*, 3rd edition, pp. 329-361. Cambridge (MA): The MIT Press.

Sober, E. 2015. *Ockham's Razor: A User's Manual*. Cambridge: Cambridge University Press.

Sommer, M. 2007. *Bones and Ochre: The Curious Afterlife of the Red Lady of Paviland*. Cambridge (MA): Harvard University Press.

Sommer, M. 2015. *Evolutionäre Anthropologie zur Einführung*. Hamburg: Junius.

Sonneville-Bordes, D. 1960. *Le Paléolithique supérieur en Périgord*. Unpublished Doctoral Dissertation, Unversité de Bordeaux I.

Sonneville-Bordes, D., J. Perrot 1954. Lexique typologique du Paléolithique supérieur. Outillage lithique : I Grattoirs - II Outils solutréens. *Bulletin de la Société préhistorique française* 51(7): 327-335.

Sonneville-Bordes, D., J. Perrot 1955. Lexique typologique du Paléolithique supérieur. Outillage lithique : III Outils composites-Perçoirs. *Bulletin de la Société préhistorique française* 52(1-2): 76-79.

Sonneville-Bordes, D., J. Perrot 1956a. Lexique typologique du Paléolithique supérieur. Outillage lithique : IV Burins. *Bulletin de la Société préhistorique française* 53(7-8): 408-412.

Sonneville-Bordes, D., J. Perrot 1956b. Lexique typologique du Paléolithique supérieur. Outillage lithique (suite et fin): V Outillage à bord abattu- VI Pièces tronquées- VII Lames retouchées- VIII Pièces variés- IX Outillage lamellaire- Pointe azilienne. *Bulletin de la Société préhistorique française* 53(9): 547-559.

Soressi, M. 2002. *Le Moustérien de tradition acheuléenne du sud-ouest de la France. Discussion sur la signification du faciès à partir de l'étude comparée de quatre sites : Pech-de-l'Azé I, Le Moustier, La Rochette et la Grotte XVI*. Unpublished Doctoral Dissertation, Université de Bordeaux.

Soressi, M., M.A. Hays 2003. Manufacture, transport and use of Mousterian bifaces. A case study from the Perigord (France). In M. Soressi, H.L. Dibble (eds.), *Multiple approaches to the study of bifacial technologies*, pp. 125-147. Philadelphia: University of Pennsylvania Museum Press.

Soressi, M., J.-M. Geneste 2011. The History and Efficacy of the *Chaîne Opératoire* Approach to Lithic Analysis: Studying Techniques to Reveal Past Societies in an Evolutionary Perspective. *PaleoAnthropology* 2011: 334-350.

Soriano, S. 2000. *Outillage bifacial et outillage sur éclat au Paléolithique ancien et moyen : coexistence et interaction*. Unpublished Doctoral Dissertation, Université de Paris X – Nanterre.

Soriano, S. 2001. Statut fonctionnel de l'outillage bifacial dans les industries du Paléolithique moyen. Propositions méthodologiques. In: D. Cliquet (eds.), *Industries à outils bifaciaux du Paléolithique moyen d'Europe occidentale*, pp. 77-83. Liège: ERAUL 98.

Soriano, S. 2005. Le Sud : une plate-forme pour le peuplement des espaces septentrionaux pendant le Pléistocène moyen récent ? In: J. Jaubert, M. Barbaza (eds.), *Territoires, déplacements, mobilité, échanges durant la Préhistoire. Terres et hommes du Sud*, pp. 63-83. Paris: CTHS.

Soriano, S. 2010. Slimak L. dir. (2008) – Artisanats et territoires des chasseurs moustériens de Champ Grand, Aix-en-Provence, MMSH. *Bulletin de la Société Préhistorique française* 107(3): 601-603.

Soriano, S., P. Villa, L. Wadley 2007. Blade technology and tool forms in the Middle Stone Age of South Africa: the Howiesons Poort and post-Howiesons Poort at Rose Cottage Cave. *Journal of Archaeological Science* 34: 681-703.

Soriano, S., P. Villa, A. Delagnes, I. Degano, L. Pollarolo, J.J. Lucejko, C. Henshilwood, L. Wadley 2015. The Still Bay and Howiesons Poort at Sibudu and Blombos: Understanding Middle Stone Age Technologies. *PLoS ONE* 10(7): e0131127.

Soulier, P. 1994. Nécrologies : Michel Brézillon. *Bulletin de la Société préhistorique française* 91(3): 162-169.

Soulier, P. 2003. André Leroi-Gourhan (25 août 1911–19 février 1986). La Revue pour l'Histoire du CNRS 8 : 54-67. URL = http://histoire-cnrs.revues.org/554 [retrieved on 20.03.2016].

Soulier, P. 2005. André Leroi-Gourhan enseignant à Lyon (1944-1956) : De l'ethnologie coloniale à l'ethnologie préhistorique. *Cahiers scientifiques - Muséum d'histoire naturelle de Lyon* HS3: 45-56.

Soulier, P. 2009. André Leroi-Gourhan, de la muséologie à l'ethnologie (1934-1946). In : J. Christophe, D.-M. Boëll, R. Meyran (eds.), *Du folklore à l'ethnologie*, pp. 205-215. Paris: Éditions du MSH.

Soulier, P. 2011. Faits matériels et formalisation des concepts chez Leroi-Gourhan. In: N. Barbe, J.-F. Bert (eds.), *Penser le concret*, pp. 15-31. Grâne: Créaphis Éditions.

Soulier, P. 2012. André Leroi-Gourhan, collecteur d'objets pour les musées (Japon avril 1937 - mars 1939). *Techniques & Culture* 57: 60-83.

Soulier, P. 2015. André Leroi-Gourhan (1911-1986), un anthropologue encyclopédiste au XXe siècle. In: P. Soulier (ed.), *André Leroi-Gourhan, « l'homme simplement »*, pp. 15-46. Paris: Éditions de Boccard.

Souriau, E. [1943] 2009. *Les différents modes d'existence*. Edited and introduced by I. Stengers and B. Latour. Paris: PUF.

Spaulding, A. 1953. Statistical techniques for the discovery of artifact types. *American Antiquity* 18: 305-313.

Spaulding, A. 1968. Explanation in Archaeology. In: S.R. Binford, L.R. Binford (eds.), *New Perspectives in Archaeology*, pp. 33-40. Chicago: Aldine.

Speth, J.D. 1972. The mechanical basis of percussion flaking. *American Antiquity* 37(1): 34-60.

Speth, J.D. 1981. The role of platform angle and core size in hard-hammer percussion flaking. *Lithic Technology* 10(1): 16-21.

Speth, J.D. 2011. Glynn Isaac: Memories and Tribute. In: J. Sept, D. Pilbeam (eds.), *Casting the Net Wide: Papers in Honor of Glynn Isaac and His Approach to Human Origins Research*, pp. 133-148. Oxford: Oxbow Books.

Spikins, P. 2012. Goodwill hunting? Debates over the 'meaning' of Lower Palaeolithic handaxe form revisited. World Archaeology 44(3): 378-392.

Stanford, P.K. 2001. Refusing the Devil's Bargain: What Kind of Underdetermination Should We Take Seriously?. *Philosophy of Science* 68: 1-12.

Stanford, P.K. 2006. *Exceeding Our Grasp. Science, History, and the Problem of Unconceived Alternatives*. Oxford: Oxford University Press.

Stanford, P.K. 2015. Unconceived alternatives and conservatism in science: the impact of professionalization, peer-review, and Big Science. *Synthese*: DOI: 10.1007/s11229-015-0856-4.

Steenhuyse, A. 2007. *Continuity and Change in Lithic Technological and Economic Strategies: The Middle and Upper Paleolithic Industries of the Brive Basin (France)*. Unpublished Doctoral Dissertation, University of Pennsylvania.

Steenhuyse, A. 2008. Review of Carolyn Szmidt, The Mousterian in Mediterranean France: A Regional, Integrative and Comparative Perspective. *PaleoAnthropology* 2008: 253-255.

Stocking. G.W. 1965. On the limits of 'presentism' and 'historicism' in the historiography of the behavioral sciences. *Journal of the History of the Behavioral Sciences* 1(2): 211-218.

Straus, L.G. 1987. Paradigm lost: a personal view of the current state of Upper Palaeolithic research. *Helinium* 27: 157-171.

Straus, L.G. 1991. Paradigm found? A research agenda for study of the Upper and Post-Paleolithic in southwest Europe. In: G.A. Clark (ed.), *Perspectives on the Past*, pp. 56-78. Philadelphia: University of Pennsylvania Press.

Straus, L.G. 1996. The Archaeology of the Pleistocene-Holocene Transition in Soutwest Europe. In: L.G. Straus, B.V. Eriksen, J.M. Erlandson, D.R. Yesner (eds.), *Humans at the End of the Ice-Age. The Archaeology of the Pleistocene-Holocene Transition*, pp. 83-99. New York/London: Plenum Press.

Straus, L.G. (ed.) 2002a. *The Role of American Archeologists in the Study of the European Upper Paleolithic*. BAR International Series 1048. Oxford: Archaeopress.

Strauss, L.G. 2002b. "American" Perspectives on the European Upper Palaeolithic? An Introduction. In: L.G. Straus (ed.), *The Role of American Archeologists in the Study of the European Upper Paleolithic*, pp. 1-5. BAR International Series 1048. Oxford: Archaeopress.

Straus, L.G. 2005. The American-European dialogue in the study of the Upper Paleolithic: some reflections on international collaboration in honor of Jesus Altuna. *Mundibe* 57: 9-18.

Straus, L.G. 2007. F(rancis) Clark Howell (1925-2007): America's Paleoanthropologist. *Journal of Anthropological Research* 63(2): 163-164.

Straus, L.G. 2017. The Chicago Connection in Spanish Paleolithic Prehistory. In: G. Delley, M. Díaz-Andreu, F. Djindjian, V.M. Férnandez, A. Guidi, M.-A. Kaeser (eds.), *History of Archaeology: International Perspectives*, pp. 111-119. Oxford: Archaeopress.

Straus, L.G, D. Meltzer, L.A. Borrero, D. Read, R. Hunter-Anderson, J. Sabloff, W. Longacre, F. Wendorf 2011. Lewis Robert Binford (November 21, 1931–April 11, 2011). *Journal of Anthropological Research* 67(3): 321-331.

Stringer, C. 2006. *Homo Britannicus: The Incredible Story of Human Life in Britain*. London: Penguin.

Stern, D. 2003. The practical turn. In: S.P. Turner, P. Roth (eds.), *The Blackwell Guidebook to the Philosophy of the Social Sciences*, pp. 185-206. Oxford: Blackwell.

Stout, D. 2011. Stone toolmaking and the evolution of human culture and cognition. *Philosophical Transaction of the Royal Society London* B 366: 1050-1059.

Stout, D., E.E. Hecht 2017. Evolutionary neuroscience of cumulative culture. *PNAS* 114(30): 7861-7868.

Stroud, S.R. 2014. Anekāntavāda and Engaged Rhetorical Pluralism: Explicating Jaina Views on Perspectivism, Violence, and Rhetoric. *Advances in the History of Rhetoric* 17(2): 131-156.

Stroud, S.R. 2015. Pragmatism, Pluralism, and World Hypotheses: Stephen Pepper and the Metaphysics of Criticism. *Philosophy and Rhetoric* 48(3): 266-291.

Sturgeon, S. 1993. The Gettier Problem. *Analysis* 53(3): 156-164.

Stutt, A., S. Shennan 1990. The Nature of Archaeological Arguments. *Antiquity* 64: 766-777.

Suchman, L. 2014. Reconfiguring practices. In: C. Coopmans, J. Vertesi, M.E. Lynch, S. Woolgar (eds.), *Representation in Scientific Practice Revisited*, pp. 333-335. Cambridge (MA)/London: The MIT Press.

Surovell, T.A. 2009. *Towards a Behavioral Ecology of Lithic Technology: Cases from Paleoindian Archaeology*. Tuscon: University of Arizona Press.

Szmidt, C. 2003. *The Mousterian in Mediterranean France: A regional, integrative and comparative perspective*. British Archaeological Reports International Series 1147. Oxford: Archaeopress.

Taborin, Y. 1993. *La parure en coquillage au Paléolithique*. Paris: Éditions du CNRS.

Taborin, Y (ed.) 1994. *Environnement et habitats magdaléniens dans le centre du Bassin parisien*. Paris: Éditions de la Maison des sciences de l'homme (DAF 43).

Tartar, E., N. Teyssandier, F. Bon, D. Liolios. 2006. Equipement de chasse, équipement domestique: Une distinction efficace? Réflexion sur la notion d'investissement technique dans les industries aurignaciennes. In: L. Astruc, F. Bon, V. Léa, P.Y. Milcent, S. Phillibert (eds.), *Normes techniques et pratiques sociales : De la simplicité des outillages pré- et protohistoriques*, pp. 107-118. Antibes: ADPCA.

Taylor, C. 1971. Interpretations and the Sciences of Man. *Review of Metaphysics* 25: 3-51.

Taylor, P.D., L.B. Jonker 1978. Evolutionary stable strategies and game dynamics. *Mathematical Biosciences* 40: 145-156.

Teilhard de Chardin, P. 1955. *Le Phénomène Humain*. Paris: Le Seuil.

Teilhard de Chardin, P. 1956. *La Place de l'Homme dans la Nature. Le Groupe Zoologique*. Paris: Éditions Albin Michel.

Teller, P. 2004. How We Dapple the World. *Philosophy of Science* 71(4): 425-447.

Tennie, C., L.S. Premo, D.R. Braun, S.P. McPherron 2017. Early Stone Tools and Cultural Transmission: Resetting the Null Hypothesis. *Current Anthropology* 58(5): 652-672.

Testart, A. 1982. *Les chasseurs-cueilleurs ou l'origine des inégalités*. Paris: Société d'Ethnographie.

Testart, A. 2005. *Éléments de classifications des sociétés*. Paris: Errance.

Testart, A. 2012. *Avant l'histoire. L'évolution des sociétés, de Lascaux à Carnac*. Paris: Éditions Gallimard.

Teyssandier, N. 2003. *Les débuts de l'Aurignacien en Europe. Discussion à partir des sites de Geißenklösterle, Willendorf II, Krems-hundssteig et Bacho-Kiro*. Doctoral Dissertation, Université de Paris X-Nanterre.

Teyssandier, N. 2006. Questioning the First Aurignacian: mono- or multi-cultural phenomenon during the formation of the Upper Paleolithic in central Europe and the Balkans. *Anthropologie* 44(1): 9-29.

Teyssandier, N. 2007. L'émergence du Paléolithique supérieur en Europe : mutations culturelles et rythmes d'évolution. *Paléo* 19: 367-390.

Teyssandier, N., F. Bon, J.-G. Bordes 2010. Within projectile range: some thoughts on the appearance of the Aurignacian in Europe. *Journal of Anthropological Research* 66(2): 209-230.

Texier, P.-J. 1984. Un débitage expérimental de silex par pression pectorales à la béquille. *Bulletin de la Société préhistorique française* 81(1): 25-27.

Texier, P.-J. 1995. The Oldowan assemblage from NY 18 site at Nyabusosi (Toro-Uganda). *CRAScP 320*(IIa): 647-653.

Texier, P.-J., L. Meignen 2011. Soixante années de technologie lithique: étapes marquantes, apports et écueils. In: F. Delpech, J. Jaubert (eds.), *François Bordes et la Préhistoire*, pp. 133-139. Paris: Éditions du C.T.H.S.

Texier, P.-J., J.P. Brugal, C. Lemorini, L. Wilson 1998. Fonction d'un site du Paléolithique moyen en marge d'un territoire: l'abri de la Combette (Bonnieux, Vaucluse). In: J.P. Brugal, L. Meignen, M. Patou-Mathis (eds.), *Économie Préhistorique: les comportements de subsistance au Paléolithique*, pp. 325-348. Antibes: APDCA.

Thacker, P.T. 1996. Hunter-Gatherer Lithic Economy and Settlement Systems. Understanding Regional Assemblage Variability in the Upper Paleolithic of Portuguese Estramadura. In: G.H. Odell (ed.), *Stone Tools. Theoretical Insights into Human Prehistory*, pp. 101-124. New York: Plenum Press.

Thévenot, L. 2001. Pragmatic regimes governing the engagement with the world. In: T.R. Schatzki, K.K. Cetina, E. von Savigny (eds.), *The Practice Turn in Contemporary Theory*, pp. 56-73. London/New York: Routledge.

Thiébaut, C. 2006. *Le Moustérien à denticulés: variabilité ou diversité techno-économique ?* (tome 1). Unpublished Doctoral Dissertation, Université de Provence – Aix-Marseille I.

Thiébaut, C. 2013. Discoid debitage stricto sensu: a method adapted to highly mobile Middle Paleolithic groups? *P@lethnology* 2013: 4-20.

Thomae, H. 1999. The nomothetic-idiographic issue: Some roots and recent trends. *International Journal of Group Tensions* 28(1): 187-215.

Thomas, D.H. 1986. Contemporary Hunter-Gatherer Archaeology in America. In: D.J. Meltzer, D.D. Fowler, J.A. Sabloff (eds.), A*merican Archaeology Past and Future: A Celebration of the Society of American Archaeology 1935-1985*, pp. 237–276. Washington D.C.: Smithsonian Institution Press.

Thomas, D.H. 1998. *Archaeology*. Third Edition. Fort Worth: Harcourt College Publishers.

Thomas, J. 1996. *Time, Culture and Identity: An interpretive archaeology*. London: Routledge.

Thompson, D'A.W. 1961 [1917]. *On Growth and Form*. Cambridge: Cambridge University Press.

Thompson, E. 2007. *Mind in life: Biology, phenomenology, and the sciences of mind*. Cambridge (MA): Harvard University Press.

Tiger, L. 1959. *Men in Groups*. London: Nelson.

Tiger, L., R. Fox 1966. The Zoological Perspective in Social Science. *Man* 1(1): 75-81.

Tiger, L., R. Fox 1971. *The Imperial Animal*. New York: Holt, Rinehart and Winston.

Tinbergen, N. 1963. On aims and methods of Ethology. *Zeitschrift für Tierpsychologie* 20: 410-433.

Tinbergen, N. 1965. *Animal behavior*. New York: Time Life Nature Library.

Tinland, F. 1977. *La différence anthropologique. Essai sur les rapports de la nature et de l'artifice*. Paris: Aubier-Montaigne.

Tixier, J. 1976. *Le campement préhistorique de Bordj Mellala, Ouargla, Algérie*. Valbonne: CREP.

Tixier, J. 1978. *Méthode pour l'étude des outillages lithiques*. Notice sur les travaux scientifiques de J. Tixier. Unpublished Soutenance sur Travaux, Université de Paris X – Nanterre.

[Tixier, J. 2012. *A Method for the Study of Stone Tools/ Méthode pour l'Étude des Outillages Lithiques*. Submitted in view of obtaining a higher doctorate (based on published work). Edited and introduced by F. Le Brun-Ricalens and translated by M.-C. Dawson and B. Gravina. Luxemburg: ArchéoLogique 4.]

Tixier, J. (ed.) 1980. *Préhistoire et Technologie lithique, 11-13 mai 1979, vol 1*. Centre de Recherche Archéologique du CNRS, publications de l'URA 28. Paris: Centre régional de publication de Sophia Antipolis.

Tixier, J., M.-L. Inizan, H. Roche 1980. *Préhistoire de la pierre taillée 1 : Terminologie et technologie*. Paris: C.R.E.P.

Tomasso, A., Naudinot, N., D. Binder, S. Grimaldi 2014. Unité et diversité dans l'Épigravettien récent de l'arc liguro-provençal. In: M. Langlais, N. Naudinot, M. Peresani (eds.), *Les groupes culturels de la transition Pléistocène-Holocène entre Atlantique et Adriatique*, pp. 155-185. Paris: Société préhistorique française.

Tomlinson, G. 2018. *Culture and the Course of Human Evolution*. Chicago: The University of Chicago Press.

Tooby, J., I. DeVore 1987. The reconstruction of hominid behavioral evolution through strategic modelling. In: W.G. Kinzey (ed.), *The Evolution of Humen Behavior: primate models*, pp. 183-237. Albany: State University of New York Press.

Topper, D.R. 1996. *Towards an Epistemology of Scientific Illustration*. Toronto: University of Toronto Press.

Torrence, R. 1983. Time budgeting and hunter-gatherer technology. In: G. Bailey (ed.), *Hunter-gatherer economy in prehistory: a European perspective* , pp. 11–22. Cambridge: Cambridge University Press

Torrence, R. (ed.) 1989a. *Time, energy and stone tools*. Cambridge: Cambridge University Press.

Torrence, R. 1989b. Preface. In: R. Torrence (ed.), *Time, energy and stone tools*, pp. vii-viii. Cambridge: Cambridge University Press.

Torrence, R. 1989c. Tools as optimal solutions. In: R. Torrence (ed.), *Time, energy and stone tools*, pp. 1-6. Cambridge: Cambridge University Press.

Torrence, R. 2001. Hunter-gatherer technology: macro- and microscale approaches. In: C. Panter-Brick, R.H. Layton, P. Rowley-Conwy (eds.), *Hunter-Gatherers: An Interdisciplinary Perspective*, pp. 73-98. Cambridge: Cambridge University Press.

Torrence, R. 2002. Thinking Big about Small Tools. *Archaeological Papers of the American Anthropological Society* 12(1) [Special Issue: Thinking Small: Global Perspective on Microlithization]: 179-189.

Tostevin, G.B. 2000. *Behavioral Change and Regional Variation across the Middle to Upper Paleolithic Transition in Central Europe, Eastern Europe, and the Levant*. Unpublished Doctoral Dissertation, Harvard University.

Tostevin, G.B. 2007. Social Intimacy, Artefact Visibility and Acculturation Models of Neanderthal–Modern Human Interaction. In: P. Mellars, K. Boyle, O. Bar-Yosef, C. Stringer (eds.), *Rethinking the Human Revolution: New Behavioural and Biological Perspectives on the Origins and Dispersal of Modern Humans*, pp. 341-357. Cambridge: McDonald Institute for Archaeological Research.

Tostevin, G.B. 2011a. Introduction [to Special Issue: Reduction Sequence, Chaîne Opératoire, and Other Methods: The Epistemologies of Different Approaches to Lithic Analysis]. *PaleoAnthropology* 2011: 293-296.

Tostevin, G.B. 2011b. Levels of Theory and Social Practice in the Reduction Sequence and Chaîne Opératoire Methods of Lithic Analysis. *PaleoAnthropology* 2011: 351-375.

Tostevin, G.B. 2012. *Seeing Lithics: A Middle Range Theory for Testing for Cultural Transmission in the Pleistocene*. Cambridge (MA): Oxbow Books.

Toth, N. 1991. The Importance of Experimental Replicative and Functional Studies in Palaeolithic Archaeology. In: J.D. Clark (ed.), *Cultural Beginnings: Approaches to Understanding Early Hominid Life-Ways in the African Savanna*, pp. 109-124. Bonn: Dr. Rudolf Habelt.

Toth, N. 1997. Artefact Assemblages in the Light of Experimental Studies. In: G.L. Isaac, B. Isaac (eds.), *Koobi Fora Research Project, Volume 5: Plio-Pleistocene Archaeology*, pp. 363-401. Oxford: Oxford University Press.

Toth, N., K. Schick 1983. The cutting edge: an experimental elephant butchery with stone tools. *Interim Evidence: Newletter of the Foundation for Research Into the Origin of Man* 5(1): 8-10.

Toth, N. 1982. *The stone technologies of early hominids in Koobi Fora, Kenya: an experimental approach*. Unpublished Doctoral Dissertation, University of California-Berkeley.

Toth, N. 1985. The oldowan reassessed: A close look at early stone artifacts. *Journal of Archaeological Science* 12(2): 101-120.

Toth, N., K. Schick 2009a. The Oldowan: The Tool Making of Early Hominins and Chimpanzees Compared. *Annual Review of Anthropology* 38: 289-305.

Toth, N., K. Schick 2009b. The Importance of Actualistic Studies in Early Stone Age Research: Some Personal Reflections. In: K. Schick, N. Toth (eds.), *The Cutting Edge: New Approaches to the Archaeology of Human Origins*, pp. 267-344. Gosport (IN): Stone Age Institute Press.

Toth, N., K.D. Schick, E.S. Savage-Rumbaugh, R.A. Sevcik, D.M. Rumbaugh 1993. Pan the Tool-Maker: Investigations into the Stone Tool-Making and Tool-Using Capabilities of a Bonobo (*Pan paniscus*). *Journal of Archaeological Science* 20: 81-91.

Toth, N., K. Schick, S. Semaw 2006. A comparative study of the stone tool-making skills of Pan, Australopithecus and Homo sapiens. In: N. Toth, K. Schick (eds.), *The Oldowan: Case Studies into the Earliest Stone Age*, pp. 155-222. Gosport (IN): Stone Age Institute Press.

Toulmin, S. 1958. *The Uses of Argument*. Cambridge: Cambridge University Press.

Trigger, B.G. 1998. 'The loss of innocence' in historical perspective. *Antiquity* 72: 694-698.

Trigger, B.G. 2003. *Artifacts & Ideas. Essays in Archaeology*. New Brunswick: Transaction Publishers.

Trigger, B.G. [1996] 2007. *A History of Archaeological Thought*. Second Edition. Cambridge: Cambridge University Press.

Triplett, T. 1990. Recent work on Foundationalism. *American Philosophical Quarterly* 27(2): 93-116.

Trout, J.D. 2007. The Psychology of Scientific Explanation. *Philosophy Compass* 2/3: 564-591.

Tsanova, T., N. Zwyns, L. Eizenberg, N. Teyssandier, F. Le Brun-Ricalens, M. Otte 2012. Le plus petit dénominateur commun : réflexion sur la variabilité des ensembles lamellaires du Paléolithique supérieur ancien d'Eurasie. Un bilan autour des exemples de Kozarnika (Est des Balkans) et Yafteh (Zagros central). *L'Anthropologie* 116(4): 469-509.

Tucker, A. 1998. Unique Events: The Underdetermination of Explanation. *Erkenntnis* 48: 59-80.

Tucker, A. 2004. *Our Knowledge of the Past: A Philosophy of Historiography*. Cambridge: Cambridge University Press.

Turnbull, M.G. 2017. Underdetermination in science: What it is and why we should care. *Philosophy Compass* 13(2): e12475.

Turner, D. 2005. Local Underdetermination in Historical Science. *Philosophy of Science* 72(1): 209-230.

Turner, D. 2007. *Making Prehistory. Historical Science and the Scientific Realism Debate*. Cambridge: Cambridge University Press.

Turner, D. 2014. Philosophical issues in recent paleontology. *Philosophy Compass* 9(7): 494-505.

Tyron, C.A., R. Potts 2011. Approaches for Understanding Flake Production in the African Acheulean. *PaleoAnthropology* 2011: 376-389.

Ugan, A., J. Bright, A. Rogers 2003. When is technology worth the trouble? *Journal of Archaeological Science* 30: 1315-1329.

Uthmeier, T. 2004. New methods in the analysis of Crimean Middle Paleolithic stone tool assemblages: flint nodules, transformation analysis and the reconstruction of on-site and off-site Neanderthal activities. In: Y.E. Demidenko (eg.), *Buran-Kaya III rock shelter, layer B – the elaton find complex for Kiik-Koba type industry of Crimean Micoquian Tradition: Compex analysis of flint artifacts*, pp. 89-108. Kiev-Simferopol: Shlyakh.

Vaesen, K., W. Houkes 2017. Complexity and technological evolution: What everybody knows?. *Biology & Philosophy* 32: 1245-1268.

Valentin, B. 1995. *Les groupes humains et leurs traditions au Tardiglaciaire dans le Bassin parisien: apports de la technologie comparée*. Unpublished Doctoral Dissertation, Université de Paris I-Sorbonne.

Valentin, B. 2005. Paléohistoire du Bassin parisien au XIIe millénaire avant J.-C. In: D. Vialou, J. Renault-Miskovsky, M. Patou-Mathis (eds.), *Comportements des Hommes du Paléolithique moyen et supérieur en Europe*, pp. 147-155. Liège: ERAUL 111.

Valentin, B. 2006. *De l'Oise à la Vienne, en passant pour le Jourdain. Jalons pour une paléohistorie des derniers chasseurs, 2 volumes*. Unpublished Habilitation Manuscript, Université Paris 1.

Valentin, B. 2008a. *Jalons pour une paléohistoire des derniers chasseurs (XIVe-VIe millénaire avant J.-C.)*. Paris: Publications de la Sorbonne.

Valentin, B. 2008b. Typologie vs Typologie (SIC!). Comment la technologie contribue à raffiner la typologie des armatures lithiques. In: T. Aubry, F. Almeida, A.C. Araujo, M. Tiffagom (eds.), *Space and Time: Which Diachronies, which Synchronies, which Scales?*, pp.189-196. Oxford: Archaeopress.

Valentin, B. 2011. *Le Paléolithique*. Paris: PUF.

Valentin, B. 2015 (in collaboration with M. Olive, F. Valla, F. Audouze, S.A. de Beaune, P. Soulier, P. Chambon and P. Bodu). Où est l'ethnologie préhistorique ? In: P. Soulier (ed.), *André Leroi-Gourhan, « l'homme simplement »*, pp. 173-186. Paris: Éditions de Boccard.

Valentin, B., N. Pigeot 2000. Éléments pour une chronologie des occupations magdaléniennes dans le Bassin parisien. In: B. Valentin, P. Bodu, M. Christensen (eds.), *L'Europe centrale et septentrionale au Tardiglaciaire*, pp. 129-138. Nemours: Éditions APRAIF.

Valentin, B., F. Bon 2012. De la complexité des sociétés paléolithiques. In: S.A. de Beaune, H.-P. Francfort (eds.), *L'archéologie à découvert*, pp. 176-183. Paris: CNRS Éditions.

Valentin, B., G. Fosse, C. Billard 2004. Aspects et rythmes de l'azilianisation dans le Bassin parisien. Caractérisation de l'industrie lithique recueillie au Cornet (locus 33) à Ambenay, Eure. *Gallia préhistoire* 46: 171-209.

Valentin, B., J.-M. Geneste, S. Maury, H. Roche, J. Pelegrin 2005. "Homo sapiens" pouvait être plus savant. *Libération*, 29 and 30 January 2005.

Valentin, B., S. Griselin, L. Mevel (eds.) 2013. *Paléolithique final et Mésolithique dans le Bassin parisien et ses marges. Habitats, sociétés et environnements*. Unpublished collective research report, UMR 7041/SRA de la région Centre, Nanterre/Orléans.

Van Andel, T.H., W. Davies (eds.) 2003. *Neanderthals and modern humans in the European landscape during the last glaciation*. Oxford: Oxbow Books.

Van Huyck, J.B., R.C. Battalio, R.O. Beil 1990. Tacit Coordination Games, Strategic Uncertainty, and Coordination Failure. *The American Economic Review* 80(1): 234-248.

Van Peer, P. 1992. *The Levallois Reduction Strategy*. Madison: Prehistory Press.

Van Reybrouck, D. 2012. *From Primitives to Primates. A History of Ethnographic and Primatological Analogies in the Study of Prehistory*. Leiden: Sidestone Press.

Varela, F.J. 1979. *Principles of biological autonomy*. New York: Elsevier North Holland.

Varela, F.J., H.R. Maturana, R. Uribe 1974. Autopoiesis: the organization of living systems, its characterization and a model. *Biosystems* 5: 187-196.

Villa, P. 1991. Middle Pleistocene prehistory in south-western Europe: the state of our knowledge and ignorance. *Journal of Archaeological Research* 47: 193-217.

Villa, P., A. Delagnes, L. Wadley 2005. A late Middle Stone Age artifact assemblage from Sibudu (KwaZulu-Natal): comparisons with the European Middle Paleolithic. *Journal of Archaeological Science* 32: 399-422.

Vita-Finzi, C., E.S. Higgs 1970. Prehistoric Economy in the Mount Carmel area of Palestine: site catchment analysis. *Proceedings of the Prehistoric Society* 36: 1-37.

von Neumann, J., O. Morgenstern 1944. *Theory of Games and Economic Behavior*. Princeton: Princeton University Press.

von Wright, G.H. 1971. *Explanation and Understanding*. Ithaca: Cornell University Press.

Vrba, E.S. 1985. Ecological and Adaptive Changes Associated with Early Hominid Evolution: In: E. Delson (ed.), *Ancestors: The Hard Evidence*, pp. 63-71. New York: Alan R. Liss.

Vrba, E.S. 1993. The Pulse That Produced Us. *Natural History* 102(5): 47-51.

Vrba, E.S. 2006. Role of Environmental Stimuli in Hominid Origins. In: W. Henke, H. Rothe, I. Tattersall (eds.), *Handbook of Palaeoanthropology, Vol. 3: Phylogeny of Hominines*, pp. 1-41. New York: Springer.

Wallace, I.J., J.J. Shea 2006. Mobility patterns and core technologies in the Middle Paleolithic of the Levant. *Journal of Archaeological Science* 33(9): 1293-1309.

Walter, A. 1993. An Interview with Robin Fox. *Current Anthropology* 34(4): 441-452.

Wargo, M.C. 2009. *The Binford-Bordes Debate: Transatlantic Interpretive Traditions in Palaeolithic Archaeology*. Unpublished Doctoral Dissertation, University of Texas at Arlington.

Warnier, J.-P. 1999. *Construire la culture matérielle. L'homme qui pensait avec ses doigts*. Paris: PUF.

Warnier, J.-P. 2009. Technology as efficacious action on objects... and subjects. *Journal of Material Culture* 14(4): 459-470.

Washburn, S.L. 1959. Speculations on the interrelations of the history of tools and biological evolution. *Human Biology* 31: 21-31.

Washburn, S.L. 1960. Tools and human evolution. *Scientific American* 203: 63-75.

Watson, P.J., S.A. LeBlanc, C.L. Redman 1984. *Archaeological Explanation: The Scientific Method in Archaeology*. New York: Columbia University Press.

Wei, G., W. Huang, E. Boëda, H. Forestier, C. He, S. Chen, J. Zhao, Y. Li, Y. Hou, L. Pang, Y. Wu 2017. Recent discovery of a unique Paleolithic industry from the Yumidong Cave site in the Three Gorges region of Yangtze River, southwest China. *Quaternary International* 434: 107-120.

Welbourne, M. 1981. The Community of Knowledge. *Philosophical Quarterly* 31(125): 302-314.

Wenban-Smith, F. 2004. Handaxe typology and Lower Palaeolithic cultural development: ficrons, cleavers and two giant handaxes from Cuxton. *Journal of the Lithics Studies Society* 25: 11-21.

Wenban-Smith, F. 2017a. Appendix 6. Worked flint post-excavation analysis methods. In: F. Wenban-Smith, E. Stafford, M.R. Bates (eds.), *Prehistoric Ebbsfleet: excavations and research in advance of High Speed 1 and South Thameside Development Route 4, 1989-2003*, pp. 506-512. Salisbury: Wessex Archaeology.

Wenban-Smith, F. 2017b. Lithic artefacts: overview and approach to analysis. In: F. Wenban-Smith, E. Stafford, M.R. Bates (eds.), *Prehistoric Ebbsfleet: excavations and research in advance of High Speed 1 and South Thameside Development Route 4, 1989-2003*, pp. 325-331. Salisbury: Wessex Archaeology.

Wendorf, F. 2003. J. Desmond Clark 1916-2002. *Biographical Memoirs of the National Academy of Sciences* 83: 3-16.

West, D., A. Montet-White 1990. Raw Material Use. In: A. Montet-White (ed.), *The Epigravettian Site of Grubgraben, Lower Austria: The 1986 & 1987 Escavations*, pp. 121-131. Liège: Service de préhistoire (ERAUL 40).

White, M. 1998. On the Significance of Acheulean Biface Variability in Southern Britain. *Proceedings of the Prehistoric Society* 64: 15-44.

White, M., F. Foulds 2018. Symmetry is its own reward: on the character and significance of Acheulean handaxe symmetry in the Middle Pleistocene. *Antiquity* 92(362): 304-319.

White, T. 2007. Obituary: F. Clark Howell (1925–2007). Palaeoanthropologist who defined a discipline. *Nature* 447(3): 52.

White, T., N. Toth 2007. Carnivora and carnivory: assessing hominid toothmarks in zooarchaeology. In: T.R. Pickering, K. Schick, N. Toth (eds.), *Breathing Life into Fossils: Taphonomic Studies in Honor of C.K. (Bob) Brain*, pp. 281-296. Gosport (IN): Stone Age Institute Press.

White, W.J. 2014. Disciplinarity and the Rhetoric of Science: A Social Epistemological Reception Study. *Poroi* 10(2): Article 6.

Whitehead, A.N. 1929. *Process and Reality*. New York: Macmillan.

Willermet, C.M., G.A. Clark 1995. Current views: Paradigm crisis in modern human origins research. *Journal of Human Evolution* 29: 487-490.

Williams, J.K. 2003. *Examining the Boundaries of the Levantine Aurignacian*. Unpublished Doctoral Dissertation, Southern Methodist University (Dallas).

Williams, M. 1980. Coherence, Justification, and Truth. *The Review of Metaphysics* 34(2): 243-272.

Williamson, J. 2011. Mechanistic Theories of Causality Part I. *Philosophy Compass* 6(6): 421-432.

Willey, G.R., P. Phillips 1958. *Method and Theory in American Archaeology*. Chicago: University of Chicago Press.

Willey, G.R., J.A. Sabloff 1980. *A History of American Archaeology*, Second Edition. San Francisco (CA): Freeman and Co.

Windelband, W. 1904 [1894]. *Geschichte und Naturwissenschaft*, 3rd Edition. Straßburg: Heitz.

Winsor, M.P. 2006. The creation of the essentialism story: An exercise in metahistory. *History and Philosophy of the Life Sciences* 28(2): 149-174.

Winterhalder, B. 1981. Foraging strategies in the boreal environment: an analysis of Cree hunting and gathering. In: B. Winterhalder, E.A. Smith (eds.), *Hunter-gatherer Foraging Strategies: Ethnographic and Archaeological Analyses*, pp. 66-98. Chicago: University of Chicago Press.

Winterhalder, B. 2001. The behavioural ecology of hunter-gatherers. In: C. Panter-Brick, R.H. Layton, P. Rowley-Conwy (eds.), *Hunter-Gatherers: An Interdisciplinary Perspective*, pp. 12-38. Cambridge: Cambridge University Press.

Winterhalder, B., E.A. Smith 2000. Analyzing Adaptive Strategies: Human Behavioral Ecology at Twenty-Five. *Evolutionary Anthropology* 9(2): 51-72.

Wisniewski, B. 2003. *La notion de culture en archéologie préhistorique ou « Cultures préhistoriques » : de quoi s'agit-il ?*. Unpublished Master Dissertation (Mémoire de D.E.A), Université de Bordeaux I.

Withagen, R., H.J. de Poel, D. Araújo, G.-J. Pepping 2012. Affordances can invite behavior: reconsidering the relationship between affordances and agency. *New Ideas in Psychology* 30(2): 250-258.

Wittgenstein, L. 1958. *Philosophical investigations* [Vol. 255]. Oxford: Blackwell.

Wobst, H.M. 1977. Stylistic Behavior and Information Exchange. In: C. Cleland (ed.), *For the Director: Essays in honor of James B. Griffin*, pp. 317-342. Ann Arbor: Regents of the University of Michigan.

Woodward, J. 2003. *Making Things Happen: A Theory of Causal Explanation*. Oxford: Oxford University Press.

Wragg Sykes, R. 2009. *Neanderthals in Britain: Late Mousterian Archaeology in Landscape Context*. Unpublished Doctoral Dissertation, University of Sheffield.

Wylie, A. 1985. Between Philosophy and Archaeology. *American Antiquity* 50(2): 478-490.

Wylie, A. 1989. The Interpretive Dilemma. In: V. Pinsky, A. Wylie (eds.), *Critical Traditions in Contemporary Archaeology. Essays in the Philosophy, History and Socio-Politics of Archaeology*, pp. 18-27. Cambridge: Cambridge University Press.

Wylie, A. 2002. *Thinking from Things. Essays in the Philosophy of Archaeology*. Berkeley: University of California Press.

Wylie, A., R. Chapman 2015. Material Evidence. Learning from archaeological practice. In: R. Chapman, A. Wylie (eds.), *Material Evidence. Learning from archaeological practice*, pp. 1-20. London: Routledge.

Wymer, J.J. 1968. *Lower Palaeolithic Archaeology in Britain*. London: John Baker Publishers Ltd.

Wynn, T. 1979. The intelligence of later Acheulean hominids. *Man* 14: 371-391.

Wynn, T. 1995. Handaxe enigmas. *World Archaeology* 27(1): 10-24.

Wynn, T. 2000. Symmetry and the evolution of the modular linguistic mind. In: P. Carruthers, A. Chamberlain (eds.), *Evolution and the human mind: modularity, language and meta-cognition*, pp. 113-139. Cambridge: Cambridge University Press.

Wynn, T. 2002. Archaeology and cognitive evolution. *Behavioral and Brain Sciences* 25: 389-438.

Wynn, T., F.L. Coolidge 2016. Archaeological insights into hominin cognitive evolution. *Evolutionary Anthropology* 25: 200-213.

Wynn, T., J.A.J. Gowlet 2018. The handaxe reconsidered. *Evolutionary Anthropology* 27(1): 21-29.

Yellen, J.E. 1977. *Archaeological Approaches to the Present: Models for Reconstructing the Past*. New York: Academic Press.

Yellen, J., A. Brooks, D. Helgren, M. Tappen, S. Ambrose, R. Bonnefille, J. Feathers, G. Goodfriend, K. Ludwig, P. Renne, K. Steward 2005. The Archaeology of Aduma Middle Stone Age: Sites in the Awash Valley, Ethiopia. *PaleoAnthropology* 2005: 25-100.

Young, J.O. 1995. *Global Anti-realism*. Avebury: Aldershot.

Young, J.O. 2001. A Defence of the Coherence Theory of Truth. *The Journal of Philosophical Research* 26: 89-101.

Young, J.O. 2016. The Coherence Theory of Truth. In: E.N. Zalta (ed.), *The Stanford Encyclopedia of Philosophy* (Winter 2016 Edition), URL = https://plato.stanford.edu/archives/win2016/entries/truth-coherence/ [last accessed 15.02.2018].

Boxes

Box 1 **The issue of unconceived alternatives**

The ‘problem of unconceived alternatives’ has been introduced to philosophy of science by Kyle Stanford (2001, 2006). Stanford argues that the most serious challenge to the idea that our current theories adequately reflect reality is our inability to even *conceive of* credible alternatives. Stanford illustrates his point with cases from the history of science. He shows that scholars have indeed often failed to come up with alternative theories even though these theories were already reasonably well-confirmed by the evidence available at that time. This ‘robust historic pattern,’ he suggests, gives us every reason to expect that current science faces similar issues. In order to guarantee that we currently possess the *best* theories to explain the presently available evidence, one would need to ensure that we are actually testing the full spectrum of promising theory contenders. According to Stanford (2015), there is good reason to believe that scientists does not work in this way.

One reason is that modern science tends to be extremely *conservative* in inventing, developing, or even discussing novel or unconventional theories. Another reason is the social and institutional structure of science, which promotes fragmentation and hyper-specialisation. Under these conditions, it is highly likely that individual scientists are not even able to draw from the full range of *already conceived* theoretical alternatives. In general, which kinds of theories are envisioned and put forth by particular researchers also depends on the logic of theorisation, the dynamics of a given discourse, and the nature of the already developed space of theories within a given research community.

Although it has been correctly emphasised that larger research communities may be less vulnerable to the ‘problem of unconceived alternatives’ than individual scientists (e.g., Forber 2008; Godfrey-Smith 2008), research communities are also constraining factors of theory-envisioning. There is for example no guarantee that different research communities or even smaller social units of research have the *same* capacity for creating and testing new theories. And even if they would generally have the same capacity to do so, they may still come up with fundamentally different theories to compete with their current theories. Likewise, there is no warrant that such differing ‘collectives of theorisation’ will share their theories or even accept them as notable knowledge contenders. It is therefore possible that research communities can sometimes even aggravate the ‘problem of unconceived alternatives.’

Stanford’s (2015) more recent argument that especially modern science with its funding structure, highly differentiated institutional apparatus, developed reputation system, and internal control-mechanisms (i.e., peer-review) has ‘generated steadily mounting obstacles to revolutionary, transformative, or unorthodox scientific theorising’ and ‘fosters an exceedingly and increasingly theoretically conservative form of inquiry’ is noteworthy in this context. The ability of scholars to conceive of theoretical alternatives might therefore be *structurally* compromised.

Box 2 **Dogmatism**

Dogmatism is a cognitive fallacy. A dogmatists is somebody 'whose beliefs exceed her/his cognitive grounds for belief' (Pepper 1942: 11). Dogmatism typically entails the outright rejection of beliefs and knowledge claims that violate with one's own structure of belief. It often involves cognitive inflexibility and a general unwillingness to engage in serious argumentation. Instead of grappling with the encountered arguments, dogmatists tend to dismiss their status as argument ('this is mere opinion!' or 'this is nothing more than unsubstantiated belief!') or simply juxtapose their own beliefs claiming that they are evidently more convincing. The dogmatist therefore usually resists to search for new cognitive grounds, independently of whether they may interfere with his currently held beliefs or not. Accordingly, the 'dogmatic stance' is quick in the proclamation of 'self-evident' principles and 'indubitable' facts. Strong appeals to 'authority' may also smell suspiciously dogmatic. The dogmatist, as Pepper (*idem*) correctly notes, is thus "a more serious character than the utter sceptic. He is the dictator of cognition. He will put you down by main force. And he is no myth."

From this characterisation it becomes clear that a 'dogmatic stance' is undesirable in science. Not only does it sabotage the quest for new and potentially contradictory arguments, it also 'freezes' scientific discourse and hampers the promotion of new ideas. Perhaps most importantly, however, dogmatism undermines the development of a pluralistic outlook in science. Because the dogmatist is firm in insisting on the cognitive adequacy of her/his structure of belief and rejects debating alternative viewpoints, she/he tends to foster epistemological intolerance. Alternative viewpoints can then easily be discredited as 'speculative,' 'lacking solid factual grounds,' or as being 'non-scientific.' If science aspires to promote the 'freedom of thought' and a 'democracy of opinions,' dogmatism must therefore be opposed.

Box 3 **The underdetermination of knowledge claims**

The ‘underdetermination thesis’ posits that for any theory or body of theory, implicit or explicit, and any body of observation, there exists at least one other theory, such that both theories are consistent with the observations but differ ontologically (cf. Lyre 2011: 235). This idea of theory underdetermination is not to be conflated with the ‘Duhem-Quine thesis’ claiming confirmational holism (e.g., Boylan and O’Gorman 2013) or the ‘Humean problem of induction’ concerning the limit of evidence, especially past evidence (e.g., Henderson 2018). There are different versions of the ‘underdetermination thesis’ and one should in particular distinguish between stronger and weaker variants. Willard Quine (1975: 313) for instance, who contributed substantially to our understanding of theory underdetermination, championed a rather strong version of the thesis:

> “If all observable events can be accounted for in one comprehensive scientific theory – one system of the world, to echo Duhem's echo of Newton – then we may expect that they can all be accounted for equally in another, conflicting system of the world. We may expect this because of how scientists work. For they do not rest with mere inductive generalizations of their observations: mere extrapolation to observable events from similar observed events. Scientists invent hypotheses that talk of things beyond the reach of observation. The hypotheses are related to observation only by a kind of one-way implication; namely, the events we observe are what a belief in the hypotheses would have led us to expect. These observable consequences of the hypotheses do not, conversely, imply the hypotheses. Surely there are alternative hypothetical substructures that would surface in the same observable ways. Such is the doctrine that natural science is empirically under-determined; under-determined not just by past observation but by all observable events.”

Turnbull (2017) distinguishes between four major variants of the ‘underdetermination thesis.’ Each of these variants favours a different view of how theory appears to be underdetermined by the evidence and when the problem applies. Is underdetermination an issue in every theory choice or do only certain theory choices involve underdetermination? The first variant is *equivalence underdetermination* which holds that every theory is underdetermined by the evidence and there exists consequently at least one rival theory with identical empirical consequences. The second is *holist underdetermination*. This view claims that underdetermination follows from the problem of conformational holism and that every theory choice is therefore typically stronger determined by its inter-theory dependencies than by the evidence that purportedly supports it. The third variant is *transient* underdetermination which claims that future evidence may eventually direct us to conclusively discriminate between competing theories, but the current evidence is insufficient to achieve this. The fourth variant is *practical underdetermination* which holds that only a subset of theories in some practices of science is underdetermined by the presently available evidence. As Lyre (2011) has indicated, all variants of underdetermination may concern either the theory’s ‘entity content’ or its ‘structural content.’

The standard implication of the ‘underdetermination thesis’ is that theoretical knowledge is difficult to secure conclusively. There may always be knowledge contenders matching the same observations. Whether ‘theory’ is understood as an entity that is categorically distinct from ‘data’ or whether it concerns a single theoretical claim or a set of interconnected theories does in principle not matter here. All science is thus potentially affected by theory and knowledge underdetermination.

Box 4 **Who is Stephen C. Pepper?**

Stephen C. Pepper (1891-1972) was a North American philosopher whose work has largely been forgotten after World War II, partly because of the large-scale diaspora of European, most notably German-speaking scholars to the United States and the lasting effect this had on Anglophone philosophy. Throughout his career, Pepper worked mainly in the ‘pragmatist’ tradition and authored a number of seminal contributions in the philosophy of science and in aesthetics, which was his main area of interest. Pepper is perhaps one of the last thinkers to have presented a true panorama – or “complete survey” as he calls it – of the main cognitive tendencies that Western metaphysics has brought into existence. This systematic philosophy of the sources of all Western thinking is presented in *World Hypotheses* (1942), arguably his central text, in which he distinguished between ‘formism,’ ‘mechanism,’ ‘contextualism,’ and ‘organicism’ as the four credible modes of Western reasoning.

The significance of *World Hypotheses* lies mainly in its uniquely broad cognitive coverage. In contrast to the philosophies of Kuhn, Popper, and many others to follow, Pepper’s exposition does not start from a particular field of scientific inquiry such as physics or chemistry in order to draw conclusions about science in general, but rather highlights the structured and irreducible diversity of scientific thought, unified only by its foundation in common-sense experience. Pepper’s cognitive map, in other words, is capable to cover all areas of science – and not only the natural sciences, mathematics, and the life sciences – and anticipates many topics (e.g., incommensurability, pluralism, etc.) that dominate current inquiry into the processes we call ‘scientific’ (cf. Reck 1982). Having said this, the common thread in Pepper’s work was his interest in value and in normativity and the role these play in all human conduct. His contribution to the philosophy of science is to have shown as one of the first that also relies on values enabling specific forms of knowledge. Furthermore, his exposition of metaphor as a key source of human insight anticipated much of what was put at stake later by the ‘linguistic turn.’

More than thirty years after *World Hypotheses*, Pepper (1967), in *Concept and Quality*, argued to have intuited a fifth root metaphor worthy of being developed and systematised – the ‘purposive act;’ he proposed a fifth world theory based on it: ‘selectivism.’ These ideas, however, never really made an impact on the philosophical community of his time, which in the United States was already completely consumed by the legacy of logical and empirical positivism and early analytical philosophy. Pepper remains one of the giants of American philosophy who were never really credited for their achievements, probably also because Pepper produced hardly any influential students to carry on his work.

Box 5 **Methodological individualism vs. methodological holism**

The tension between methodological individualists and methodological holists elucidates some basic disputes in most, if not all, of the scientific disciplines. The distinction between methodological individualism and methodological holism is closely related to the polarity between 'analytic' and 'synthetic' modes of handling evidence. The debate mainly concerns the focus of analysis, the primacy of micro- or macro-explanations, and the granularity of interpretation.

Courgeau (2003: 4) for example notes that "[t]he distinction between holism and individualism stems from the fact that a social system can be viewed from two opposite perspectives: either as a totality endowed with specific properties, irreducible to those of its members, or as a set of individuals, such that all social phenomena resolve into individual decisions and actions, without involving any supra-individual factors."

Methodological individualism:

- analysis departs and revolves around individualisable units of analysis (e.g., the contribution of actors and parts);
- focus on and indispensability of micro-levels of analysis ('bottom-up' trajectory);
- explanation is based on high-granularity observations; compositional view of reality.

Methodological holism:

- analysis departs and revolves around emergent and not fully individualisable units of analysis (e.g. collective action, social phenomena);
- focus on and indispensability of macro-levels of analysis ('top-down' trajectory);
- explanation removes most granularity; anti-compositional or 'more-than-compositional' view of reality.

Box 6 **The categories of formism**

Root metaphor: (dis-)similarity, matter and form/artefact

The structural categories of 'immanent formism':

Particulars are parts in the world that can be distinguished from other parts on the basis of their qualities, traits, and so forth; each particular is a singularity but also shares some of its features with other particulars.

Characters include the qualities of particulars (e.g., colour, mass, etc.) and the relations among these qualities (a triangular flake cannot be rectangular by definition, etc.); distinct features of objects such as traits and attributes fall into this category.

Ties are the specific combinations of particulars and characters; 'ties' are ultimately mobilised to assess similarity and difference among particulars.

Participation describes the 'relations' between different structural categories; for instance, particulars can participate in characters and characters can participate in regularities, norms, and/or laws; participation hence takes typically 'set-theoretical' shape and specifies the organised (numerical) overlap of structural categories.

The **Theory of types** is a systematisation of the difference between relations and ties resulting in the identification of classes.

A **class** is a collection of particulars which participate in one or more characters.

Classification is an organisation of classes, typically proceeding from the more general to the less general.

The structural categories of 'transcendent formism':

Norms as regulating natural order in the world; the 'normalisation' of worldly order is guided by two common-sense insights: (1) artisans manufacturing different objects on the same plan or for the same reason, and (2) natural objects existing or developing according to the same plan; a norm is always a complex set of characters, so that norms cannot fully 'particularised' and thus typically transcend their materialisation.

Matter takes specific forms because it exemplifies particular norms; form is interpreted as a result of norms shaping matter.

Principles of exemplification mediate how and under which circumstances norms are materialised.

Laws are particularly strong norms which regulate occurrences in nature, that is, render them regular; they bridge one set of particulars with another set by defining the characters of first set with the characters of the other set; laws 'exist' but they have no basic existence other than in 'form.'

Amalgamation of 'immanent' and 'transcendental formism':

Basic particulars are the particulars of 'immanent formism,' which constitute the 'field of basic particulars' and can participate in norms; they constitute the domain of 'concrete existence.'

Basic participation is the kind of participation sought-for in 'immanent formism.'

Second-order particulars are norms, that is, complex characters or sets thereof (*Gestalts*), which are not fully 'particularisable' in basic particulars; second-order particulars constitute the 'field of second-order particulars' (how dependent this field is on the 'field of basic particulars' is typically disputed among formists).

Participation at a second degree is when complex characters are admitted, consisting of 'second-order particulars' participating at a second degree in other characters.

Combinations of 'immanent' and 'transcendental formism' typically superimpose the categories of the latter onto the former.

Existence describes what is ordered and can fully 'particularised' by basic particulars; categories of 'existence' are determined by analysing the domain of 'concrete existence' consisting of the 'field of basic particulars' and any characters these particulars may participate in.

Subsistence describes the field of characters and norms insofar as these are not fully 'particularisable' or exemplifiable by basic particulars (e.g., they might be considered an abstraction from basic particulars); the analysis of 'subsistence' typically centres on 'ties' and their 'relations'; the study of 'subsistence' is thus the study of second-order particulars, patterns, norms, and laws.

Time/space are typically interpreted as the ultimate 'subsistent' categories of all basic particulars which are part of the domain of 'concrete existence'; all basic particulars are then interpreted as participating in the laws of physical time and space (physicalist inclination of 'formism'), alongside other forms they may participate in.

Causality, then, is defined by the participation of patterns/regularities, norms, and laws in basic particulars regulated through the forms of (physical) space and time.

Chance is granted in formism and can be attested if no causality or other second-order participation can be evidenced.

Interferences of laws must always be taken into account since particulars and characters may participate in many different norms, patterns, and/or laws at the same time; interference may hence always result in distortion of pattern and techniques need to be devised to detect the 'normality' of pattern (e.g., by statistical means).

Box 7 **The categories of mechanism**

Root metaphor: machine, push-and-pull/causal field

'Discrete mechanism' stresses 'action by contact' and uses the image of the lever as a push-and-pull machine to make sense of the evidence; structural features of nature are loosely and ultimately 'externally related.'

'Consolidated mechanism' stresses 'action at a distance' and uses the image of the causal field to make sense of the evidence (cause-and-effect grounded in the principles of a structural field); structural features of nature are 'internally related' and ultimately derivative of a structural singularity.

The primary or 'effective' categories of mechanism:

Field of locations refers to the exact position of the parts of a machine within a spatiotemporal field; the location of the parts in relation to one another defines the effectiveness and general functioning of the machine and is indispensable for describing mechanistic functioning; the 'field of location' is typically expressed by describing parts in quantitative terms and specifying the work they do in exact equations.

Primary qualities are qualities of parts, typically expressible in exact quantitative terms, which are necessary to understand the functioning of the machine and to specify the laws that propel it; primary qualities are those qualities that are directly relevant for the type of action observed (e.g., mass, size, volume, etc.).

(Primary) Laws account for the specific configuration of primary qualities in a given field of location; this type of law is sometimes referred to as 'primary law'; primary laws are often described as functional equations specifying the observed functioning of a machine.

The secondary or 'ineffective' categories of mechanism:

Secondary qualities are qualities of parts which are not necessary to explain how a machine works; secondary qualities are those qualities that are largely irrelevant for the type of action observed (e.g., texture, colour, smell, etc.); dependent on the version of mechanism adopted, secondary qualities may be identified as mere 'epiphenomena,' that is, as products of causation but having no causal consequences themselves.

Principles explain why and how secondary qualities are attached to certain parts and why they are not randomly distributed among parts; quite often, the description of such principles enters into a description of regularities that hold between the primary and secondary qualities of the parts of a machine.

(Secondary) Laws account for the specific configuration among secondary qualities in a given field of location and the regularities that hold between primary and secondary qualities therein; secondary laws are not always demonstrable and are not a necessary feature of every causal explanation.

Mechanists tend to disagree about the importance of these secondary structural categories in providing a complete account of reality (i.e., 'materialism' amounts to the ignorance of secondary qualities, 'cognitivism' amounts to the ignorance of primary qualities, and 'reductionism' is when secondary qualities are fully explained by primary laws).

Additional structural categories of mechanism:

The **inevitable/accidental polarity** pertains to the mechanistic intuition that some features of reality are to a lesser degree determined and appear to convey some spark of accidentiality, while other features appear to be inevitable outcomes of the world's inner structure; accidentiality is interpreted as independence of the observable details and inevitability is typically defended in relation to laws; 'discrete mechanism' often emphasises independence of phenomenal details (secondary qualities), while 'consolidated mechanism' pushes the notion of the inevitability of the observable to the extremes.

Reality is a category that is defined in relation to the 'field of locations,' for whatever appears to be 'real' is real by virtue of its definite location; by contrast, what cannot be safely located in the field of locations remains ambiguous and cannot claim concrete existence; spatial and temporal structure define the nature of reality in mechanism.

Space and **time** are the fundamental categories that make up the basic field of locations and define the location of particulars therein; mechanism as a world theory is therefore closely bound to the confines of spatial and temporal existence; objects are primarily defined spatiotemporally – as space-time particulars.

Field refers to the conception proper to 'consolidated mechanism' that the field of locations furnished by space-time particulars is of such a consolidated nature that everything to be observed therein obeys to a basic and highly determinate integrated field structure (e.g., electromagnetic field, gravitational field, etc.) which provides the basis to describe the geometry of the world.

Atoms or **other elementary physical particles** differentiate the field of locations and thereby enable location and define structure; without these elementary units of matter there would be no field and without a field there can be no differentiated locations; elementary units of matter can hence be defined as the 'spatiotemporal volumes' differentiated by the primary qualities.

Similarity is interpreted as a (dis-)similarity of field structure including both primary qualities and laws as the principle structural features.

The **observable/unobservable distinction** accounts for the mechanistic key intuition that directly observable features (primary and secondary qualities) are brought into existence by more basic structural features of the world (laws, regularities, fields).

Correlation is the term that accounts for the regular association of 'effective' and 'ineffective' categories that has to be noted but rarely furnishes a basic explanation; even though correlated qualities might not explain, they can be predicted for they are regularly associated with certain configurations of primary qualities.

Specifity of response describes the idea that specific causes have specific consequences for both the configuration of primary and secondary categories; this specifity is the ultimate reason for why strong determinacy is presumed; **causality** is ultimately defined by this specifity of response principle.

Box 8 **The categories of contextualism**

Root metaphor: situation/situationality, historical context/act

The structural categories of contextualism:

Interpenetration is the basic condition under which features of reality crystallise in incidents of life; contextualism typically finds that everything in the world is made up by such incidents, which, in turn, consist of acts in context.

Relations describe the interpenetration of features within a distinct context of reality; it is typically accepted that the relations delineating a contextual whole are in-exhaustive.

Novelty and **change** describe the insight that most categories required to explain a given context and its 'itemised' occurrences are not universal but rather unique – they are context-specific; the stipulation of novelty implies that change is categorical rather than derivative and thus emerges as a sort of 'normal condition' – as a *status quo* rather than something that is in need of explanation (e.g., alterity emerges as an epistemological key category).

Disorder is a consequence of novelty and suggests that not even the order of categories or structures can be assumed; although disorder is not predicated or assumed, the ever lurking possibility of disorder emerges as a basic feature of contextualistic reality (e.g., order-disorder relations themselves become a target of analysis).

Quality and **texture** describe the relative internal uniformity of situated contexts (allowing us to speak of different contexts in the first place); quality refers to the *immanent* total meaning of a context and can be defined by the subcategories of 'spread,' 'change,' and 'fusion,' whereas texture refers to the detailed grammatical relations (that is, the *infrastructure*) of a context and can be defined by the subcategories of 'strands,' 'context,' and 'references'; because contextualism embraces radical novelty and change, these categories and subcategories may themselves be amendable to change and constant reorganisation; quality-texture relations constitute a key area of contextualistic inquiry (e.g., their relative prominence, etc.).

Spread characterises the distribution and extension of quality in time and space, e.g., its duration (qualitative time) or geographic reach; it maps how and in what sense parts already implicate or at least foreshadow their 'wholeness'; spread defines the *presence* of a context as whatever contributes to the latter's quality (events are ongoing and processual); the qualitative reading of time that spread entails typically results in the emphasis of *temporality*, rather than dimensional time.

Change within quality accounts for the radical emergentist outlook of contextualistic reasoning: any modification among a whole's parts will change and irreversibly alter the whole's total quality as well as the signification of its parts; this is conceived of as an ongoing, 'open,' and never-ending process.

Fusion describes the fact that quality constitutes a blending of texture and its details, so that the details become blurred and almost unrecognisable (i.e., taste is a fusion of a meal's ingredients); this fusion of details is what unifies quality (simplification and unification are therefore generally interpreted as a fusion of features, *ad infinitum*); the total quality of reality is therefore always regarded as a fusion of all domains of reality.

Strands capture the distinct aspects and features of a context which define its infrastructure; strands are the details of a context that contribute to its texture; they are further specified by their references.

Context is what encases and connects (relates) all relevant strands that can be taken to characterise a quality's texture.

References are intimate features of strands that help to define their role in delineating a context and the relationship between strands; references can be 'linear' (uni-directional satisfaction), 'convergent' (multi-directional, complex satisfaction), 'blocking' (hindering satisfaction), or 'instrumental' (circumventing blocked satisfaction by creation of secondary purposeful, intentional, goal-directed, and/or desire-driven satisfaction).

Thickness is a categorical feature of gathering and preparing contextualistic evidence; it responds to the inherent complexity of reality (interpenetration, novelty, potential disorder, texture-quality dynamics) and accounts for the mutual dependency between meticulous description and the in-depth interpretation of evidence (the transition between the two is therefore often blurred).

Box 9 **The categories of organicism**

Root metaphor: organism/living being, processual integration/becoming as processual individuation (genesis)

The basic categories of organicism:

Concealed organic process is what underpins any phenomenal aspect of reality and what gives meaning to observable phenomena; organic processes are 'concealed' because they are not self-evident, always need to be *diagnosed*, and are not directly given in observation (e.g., Bergson's 'static illusion' of reality).

(Organic) Structure is what is achieved or realised by organic processes; organic structures call for the analysis of their 'progressive' and 'ideal' categories.

Steps or **stages** define the transition from the progressive to the ideal and specify how concealed organic processes realise their organic structure; they hold together what is conceived of as a concealed organic development.

Directedness and **irreversibility** specify the organisation – that is, the order and the logic of succession – of the steps involved in a given organic process (teleology and consequentiality of processual change).

The 'progressive' categories of organicism:

The 'progressive' categories tend to delineate the space of description; they help to describe incomplete appearances and prepare the difficult search for their wholes.

Fragments of experience are the observable appearances of reality (distributed in space and time) which misleadingly suggest isolation, scatteredness, and/or discreteness but can in fact be integrated by specifying organic processes that lead via successive qualitative steps to distinct organic wholes (fragments are negatively signified by an integration *not* achieved).

Nexus(es) delineate the *potentiality* of fragments to reach integration with other relevant fragments; they specify possibilities of connections between fragments and how fragments reach out to other fragments to form positive or negative connections; thus, the 'internal drive' of fragments to complete themselves is organised and channelled by their nexus(es); it is therefore the interplay of nexuses which ultimately decides whether and how a range of fragments can reach integration (i.e., relationships between nexuses this also decide what fragments 'belong together').

Contradiction and **conflict** satisfy the intuition that order is to be found in the becoming (genesis) of a phenomenon, rather than in its various forms of static existence (being); contradictions are gaps, oppositions, and counteractions among fragments of experience which motivate synthetic integration and novelty and thereby facilitate the emergence of new developmental stages; contradictions are the preconditions for structural unification in terms of the 'ideal' categories (thesis-antithesis-synthesis structure); contradictions are necessary features of reality because nexus(es) reach out multi-directionally and are difficult if not impossible to tame.

Organic whole is the name for the ultimate resolution of the relevant fragments of reality in a coherent systemic whole; reference to the organic whole is typically made in both the 'progressive' and 'ideal' sets of categories; organic wholes are defined by a high degree of integration (it has to be noted, however, that integration may come in levels and so may organic wholes) and this integration may be reached by fulfilling three main criteria: (i) high degrees of inclusiveness, (ii) high degrees of determinateness, and (iii) high degrees of organicity (every systemic element implies any other).

The 'ideal' categories of organicism:

The 'ideal' categories tend to delineate the space of interpretation; they generally characterise organic wholes and seek to explain away any intrinsic fragmentariness of nature.

Organic whole (see above).

Implicitness and **transcendence** describe the double-edged affair of part-whole relations in organicism; the organic whole is found to have always been implicit in its fragments of experience (fragmentariness, in retrospect, turns out to be misleading and illusionary), while the same whole necessary transcends the interactions (i.e., contradictions) of the fragments by means of a total coherency (conflict also turns out to be misleading and illusionary) – this is why organic wholes are always abstractions of appearances; mutual implicativeness and strong interdependency of data are symptomatic of such dynamic part-whole relations and are considered to firmly anchor organic wholes; implicitness and transcendence define which fragments are *relevant* and which are *irrelevant*.

Economisation describes the ability of a discovered organic whole to save, that is, to preserve the entirety of its fragments of experience without any loss; economisation thus accounts for unification in organicism.

(One may add **idealisation** as a categorical means to reach out from the 'progressive' categories to corroborate implicitness and transcendence, to ensure economisation, and to reveal (that is, 'un-conceal') the organic whole; 'idealisation,' in this view, can be regarded as a means to 'harmonise' all relevant fragments in order to secure the 'ideal').

Derived categories of organicism:

Self-organisation and **self-regulation** are key conceptions because the general architecture of organicistic categories affords the idea that nexuses can be explained and understood in their processual integration and hence by the analysis of their internal dynamic temporal interaction; this predisposes the interpretation of object- and phenomena-specific trajectories of behaviour and change (i.e., the identification of distinct 'modes of being' or 'modes of becoming').

Complexity is found to be an inherent feature of all organic processes for these are propelled by overcoming *prima facie* chaotic elements, e.g., tensions in and between nexuses (contradictions in fragments of reality); this complexity often gives rise to systems thinking.

Strong emergence accounts for the basic organicistic intuition that our ability to predict concealed organic processes and their achievements remains generally limited; integration and individuation can be diagnosed and retrodictively made sense of but because the 'ideal' categories are the ultimate benchmark to judge the dynamics among 'processual' categories, the former cannot be deduced from the latter.

Cyclicity is the specific trade-off between particularity and universality found in organicism; although different nexuses may be characterised by unique modes of behaviour and transformation, the general trajectory of organic processes – metaphorically describable as the succession of 'birth,' 'development,' 'crisis,' 'death' or 're-integration' – is thought be a universal principle of worldly order (the dogma that the general structure of facts is predetermined but not the pathways to reach that structure); the resulting developmental scheme is necessary cyclical and long-term processes tend to be depicted as governed by various cycles and epicycles.

Box 10 **Scientific pluralism**

Scientific pluralism heralds the overcoming of dogmatic tendencies in the practice of science (cf. **Box 2**). It entails the basic recognition that there are not only substantial differences in the scientific approach throughout history, but also at *any* given moment in time. This 'horizontal' heterogeneity and basic diversity of scientific approaches is identified not as a deficiency, but as a key quality of the scientific enterprise (e.g., Kellert et al. 2006b: ix; Chang 2012) showcasing the ability of scholars to 'close in' on a given phenomenon from a variety of different interpretive angles and under variable assumptions and epistemological conditions. Appeals to scientific pluralism typically emphasise the natural limitations of various modes of inquiry, yet simultaneously stress the unique potentials of insight that each of them affords. The resulting paradox, so the argument goes, can only be resolved if one accepts that diverging approaches must somehow complement each other in order to counterbalance the parochialism they all imply.

Scientific pluralism calls attention to the irreducible 'disunity of science' (cf. Dupré 1993; Hacking 1996; Lynch 1998; Cartwright 1999; Cat 2017). It can be seen as a response to both the 'sceptical' and the 'dogmatic' challenge.' Pluralism is often motivated by the realistic possibility that no single account may fully explain any given phenomenon. This situation is sometimes regarded to be a consequence of the problem of shifting scales of investigation and the difficulties of defining complex phenomena in the first place – a result of the inescapable theory-ladenness of scientific observation. Pluralism is also invoked to account for the most difficult and enduring problems of interpretation, for example the understanding of quantum mechanics or the determination of the proper unit of selection in evolutionary biology (cf. Kellert et al. 2006b: viii). This understanding of science leads to the insight that the 'explanatory and investigative aims of science' can best be achieved, even in the long run, by sciences that are *pluralistic* in orientation (*ibid.*: ix-x). Thus, scientific pluralism opposes 'scientific monism' which holds that there can only be a single 'true' perspective on the world and only one measure to attain it.

The take home message of scientific pluralism is that there are "serious limits for drawing metaphysical conclusions from science" (Kellert et al. 2006b: xxiv). Science should be recognised as what it is – a diverse set of often inconsistent human practices. Although it certainly tells us something about the world, its various insights remain partial, contradictory, and often unconnected.

Figures

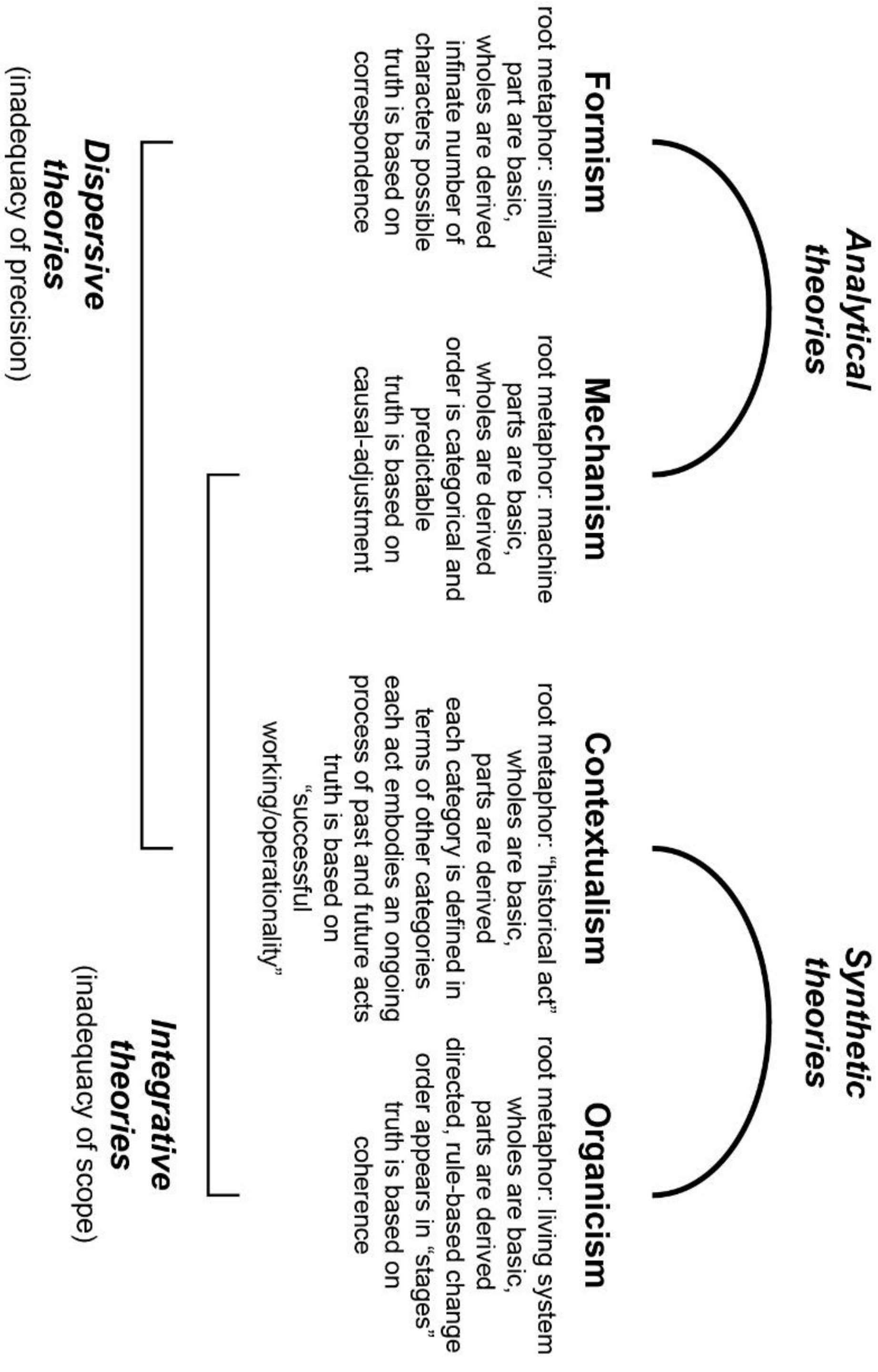


Fig. 1 **Schematic overview of the four relatively adequate world theories and their organisational structure (modified after Pepper 1942: 146).**

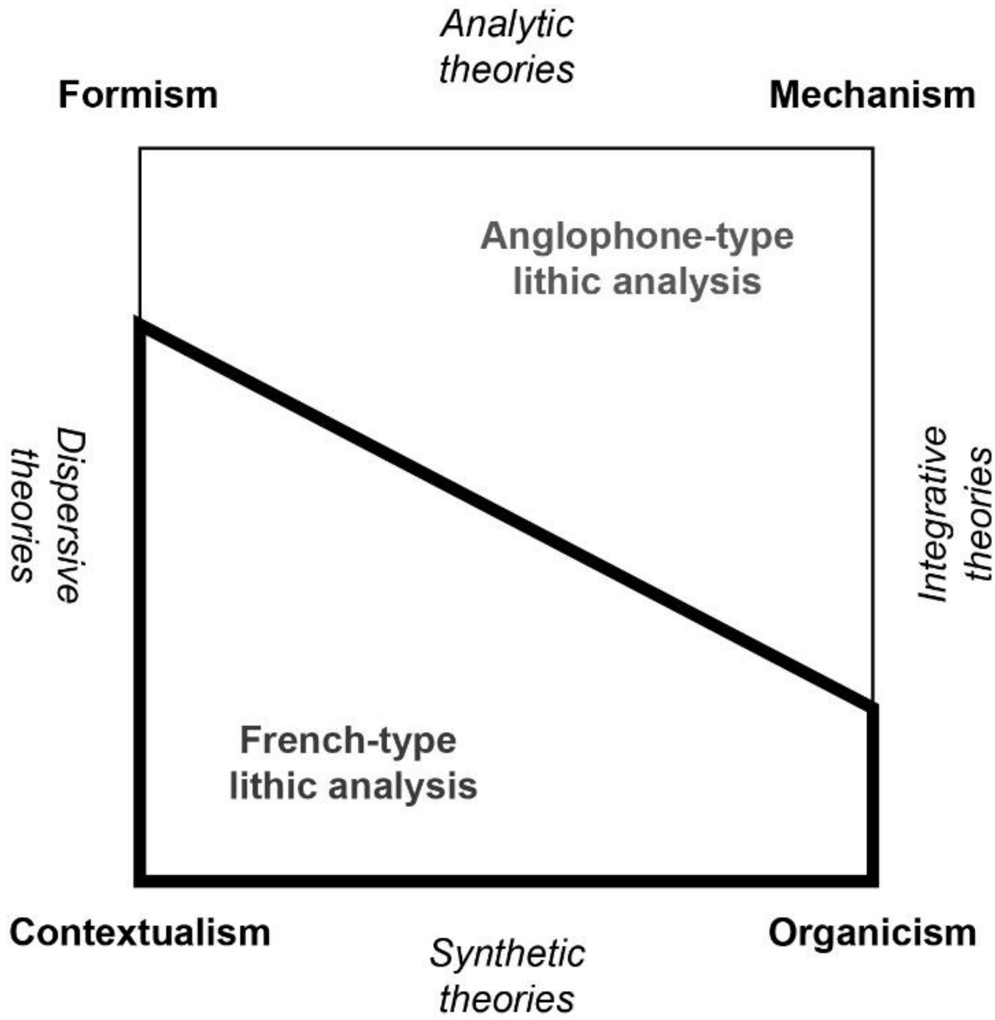


Fig. 2 **Schematic overview of the hypothesised relationship between the French-Anglophone divide in Palaeolithic archaeology and the conceptual space of the four world theories**.

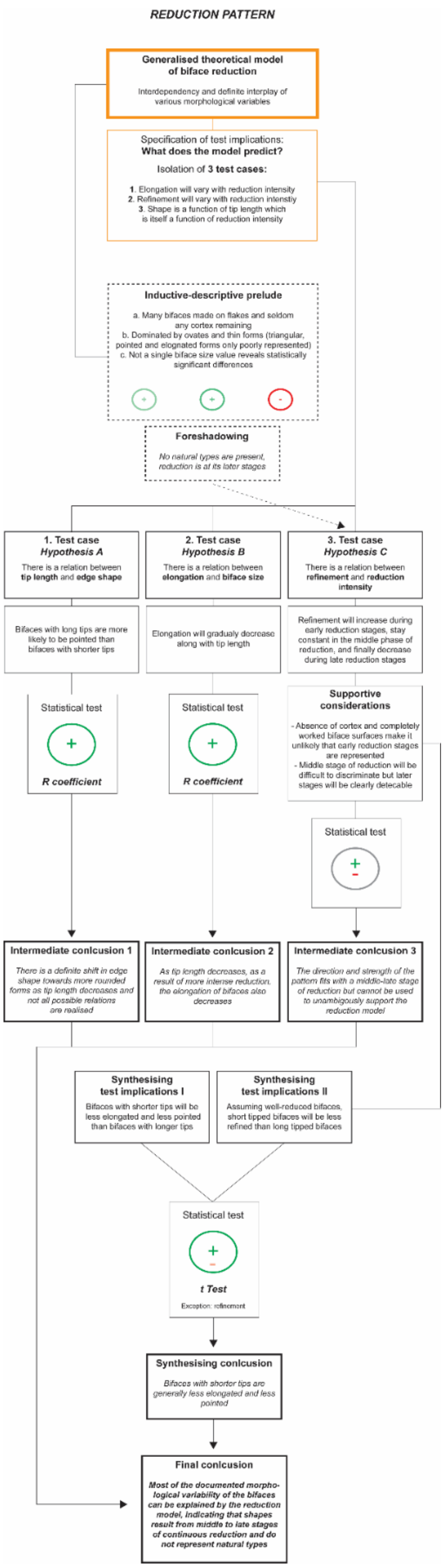


Fig. 3 **Example of a structure of inference with strong emphasis on deductive reasoning (based on McPherron 1994). The diagram exposes the succession and logic of inference underlying McPherron's biface reduction model and its application to Gouzeaucourt G. Symbol and colour coding are explained in Appendix III.1 (for the two other Anglophone case studies examined, refer also to Appendix III.1).**

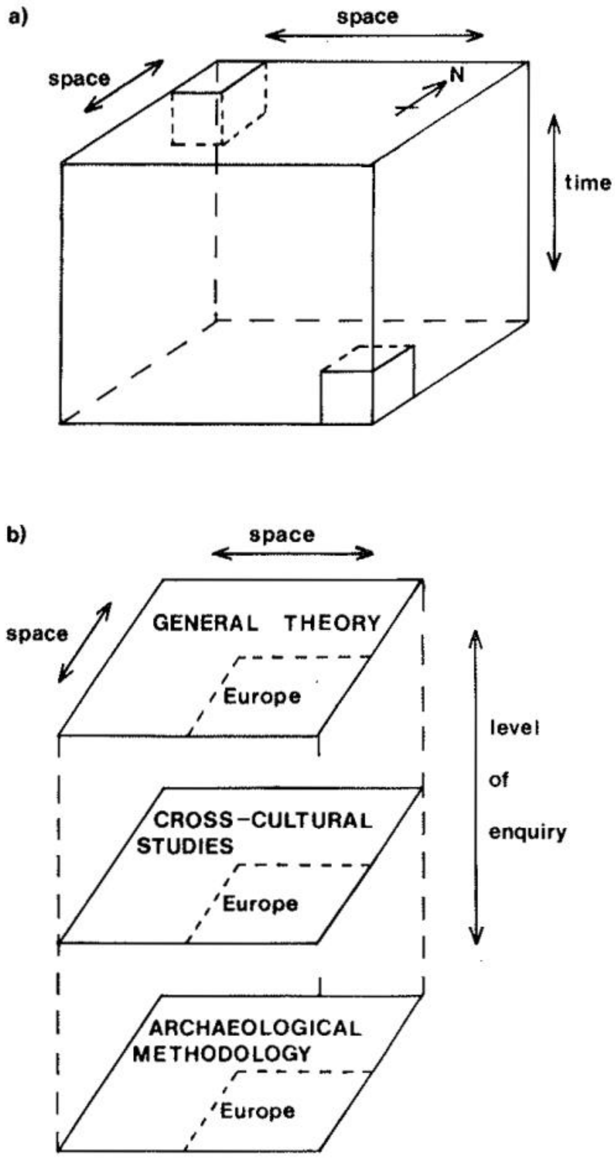


Fig. 4 **The two structures of European Prehistory according to Dennell (1983: Fig. 1). The first (a) shows the "traditional" structure based on regional studies of specific periods ('culture-history'); the second (b) is Dennell's "new" structure based on a concern with general topics (cross-cultural, theoretical) rather than regional or period specifics (*Economic Prehistory, New Archaeologies*, etc.). Note in particular the layered structure of the latter and the indicated relationship between the 'level of enquiry' and generality of the same; the envisioned and clearly 'analytic' separation between 'method' and 'theory' is directly reflected in this construal.**

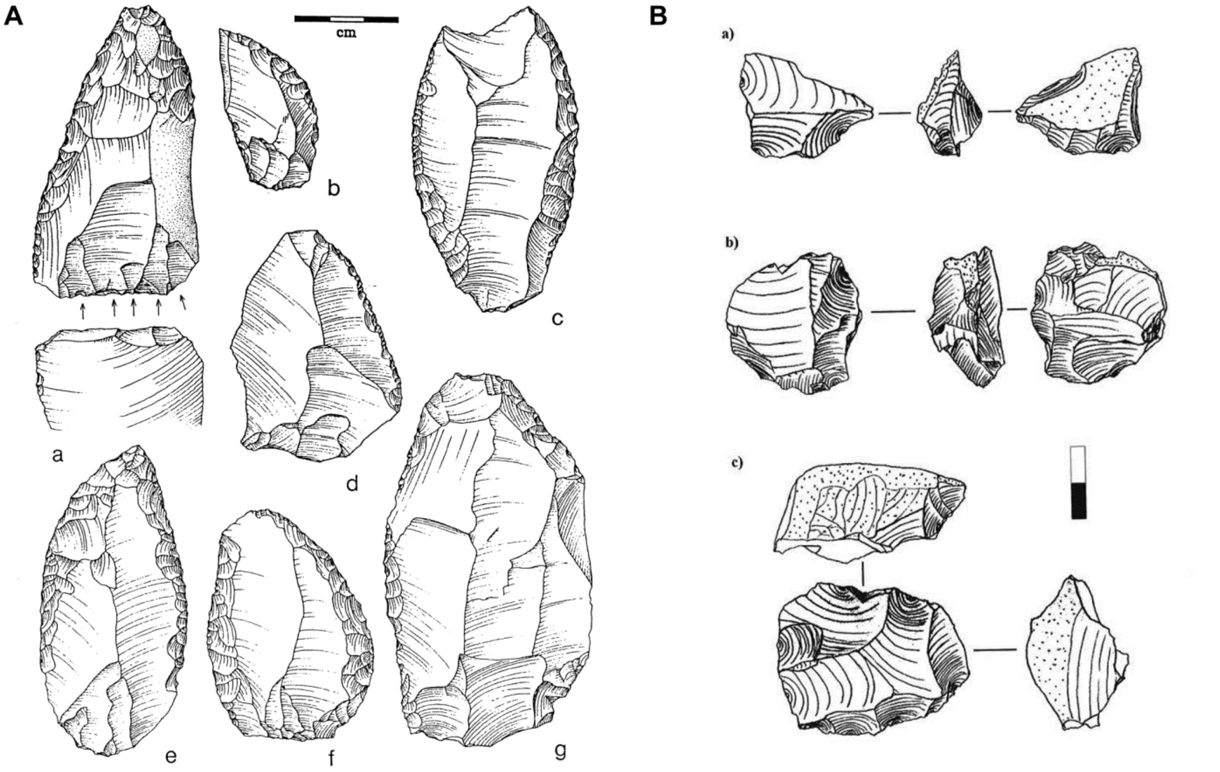


Fig. 5 **Two examples of lithic object drawings in the 'illustrative' mode of visualisation. [A] Plate-like arrangement of different Mousterian scraper types from Biache Saint-Vaast IIA (Dibble 1995a: Figure 7.5). Note that there is no explicit system of grouping except for the fact that scrapers are concerned; the purpose is to give the reader an impression or overview of how the scrapers look like in general. This figure is presented in the introductory section of the paper. [B] Plate-like arrangement of Micoquian cores from Kulna 7a (Tostevin 2012: Appendix Fig. 2A). Note that these pieces are simply described as 'cores' and are catalogued in the appendix after the primary analysis has been presented. Note also that all pieces are presented in a relatively naturalistic manner.**

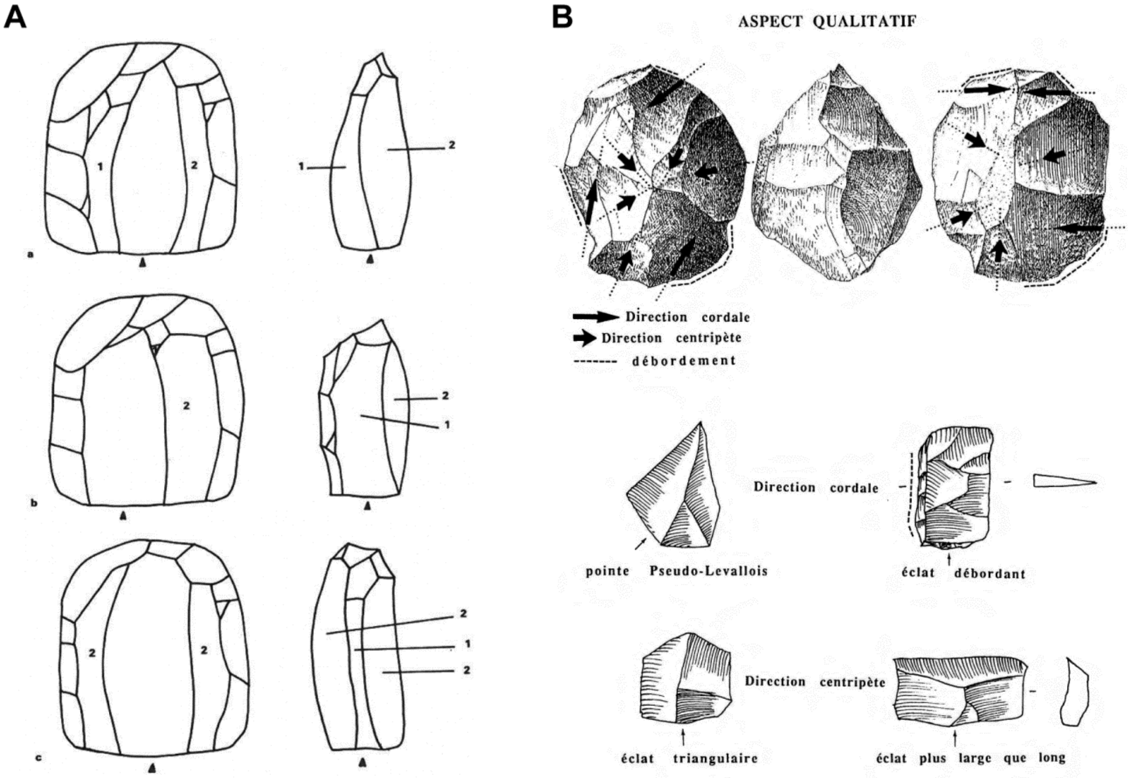


Fig. 6 **Two examples of visualising technical 'complementarity' between cores and blanks. [A] Relationship between Levallois cores and 'tertiary' blanks within the unidirectional mode of 'recurrent Levallois' (Boëda 1988: Fig. 18.16). Note the dialectical relationship established between core and blank scar-patterns and -biographies (numbers indicate geographic relationships and the order of removal). [B] Qualitative aspects of characteristic core-blank relationships of the Discoid method in the Kulna Micoquian (Boëda 1995b: Abb. 16). Note that Discoid technology is conceptualised as supporting four main blanks-types as a consequence of its specific volumetric core-architecture and the resulting two primary gestures of exploitation ('cordial' and 'centripetal'); two pairs of two blank-types are thought to correspond to either of these gestures.**

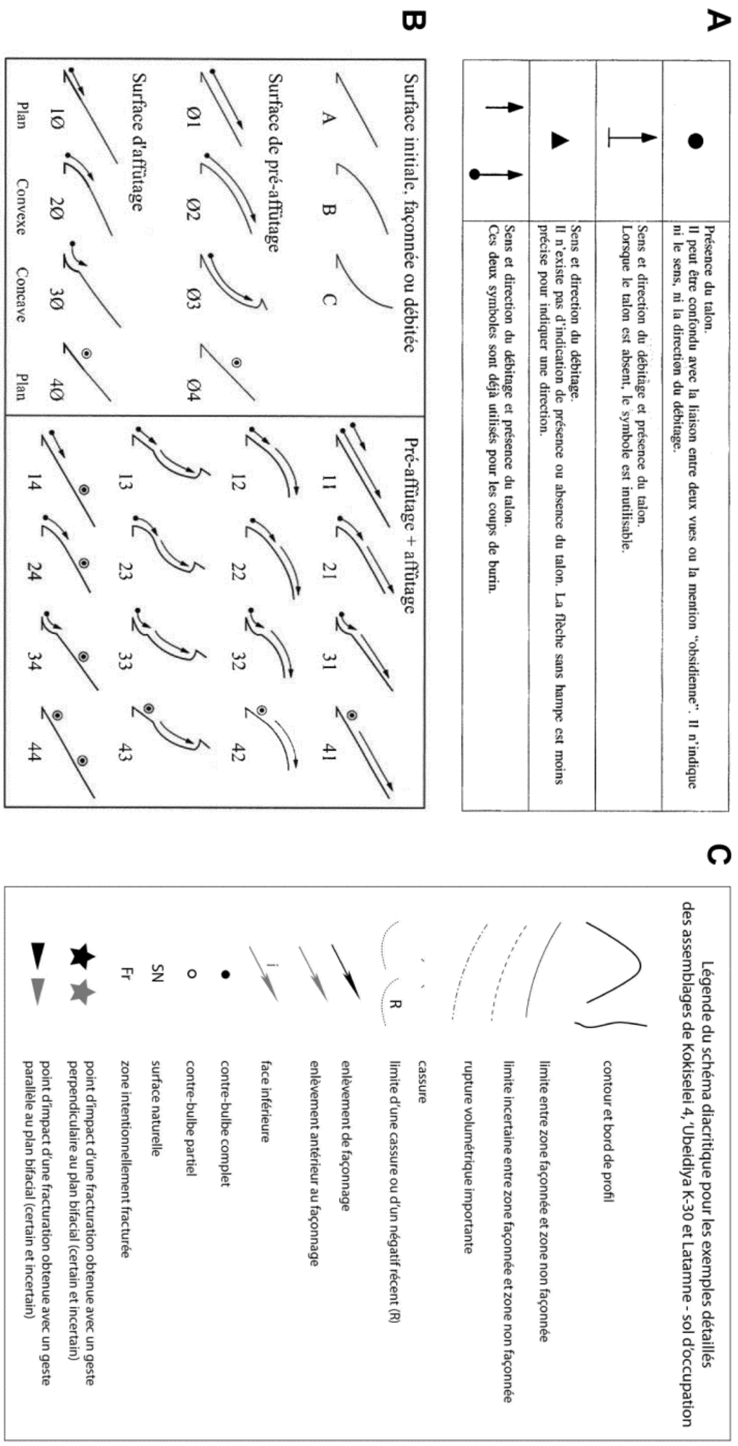


Fig. 7 **Examples of elaborate symbolic coding of various technical characteristics of lithic objects. [A] Technical symbols to indicate the direction of removal, presence of bulb of percussion, presence of burin-blow and the degree of scar-readability (Inizan et al. 1995: Fig. 126). [B] Codification of different cutting-edge configurations to describe varying functional tool potentials (Soriano 2000: Fig. 141). [C] Various technical symbols to describe the multiple dimensions of an object's *schéma diacritique* (Chevrier 2012: Annexe 3.2). Note that [A] is part of the representational innovation ushered in by the 'technological revolution,' while [B] and [C] are a product of ongoing attempts to rethink lithic tools and their techno-functionality (notion of the 'UTF,' see Chapter 5).**

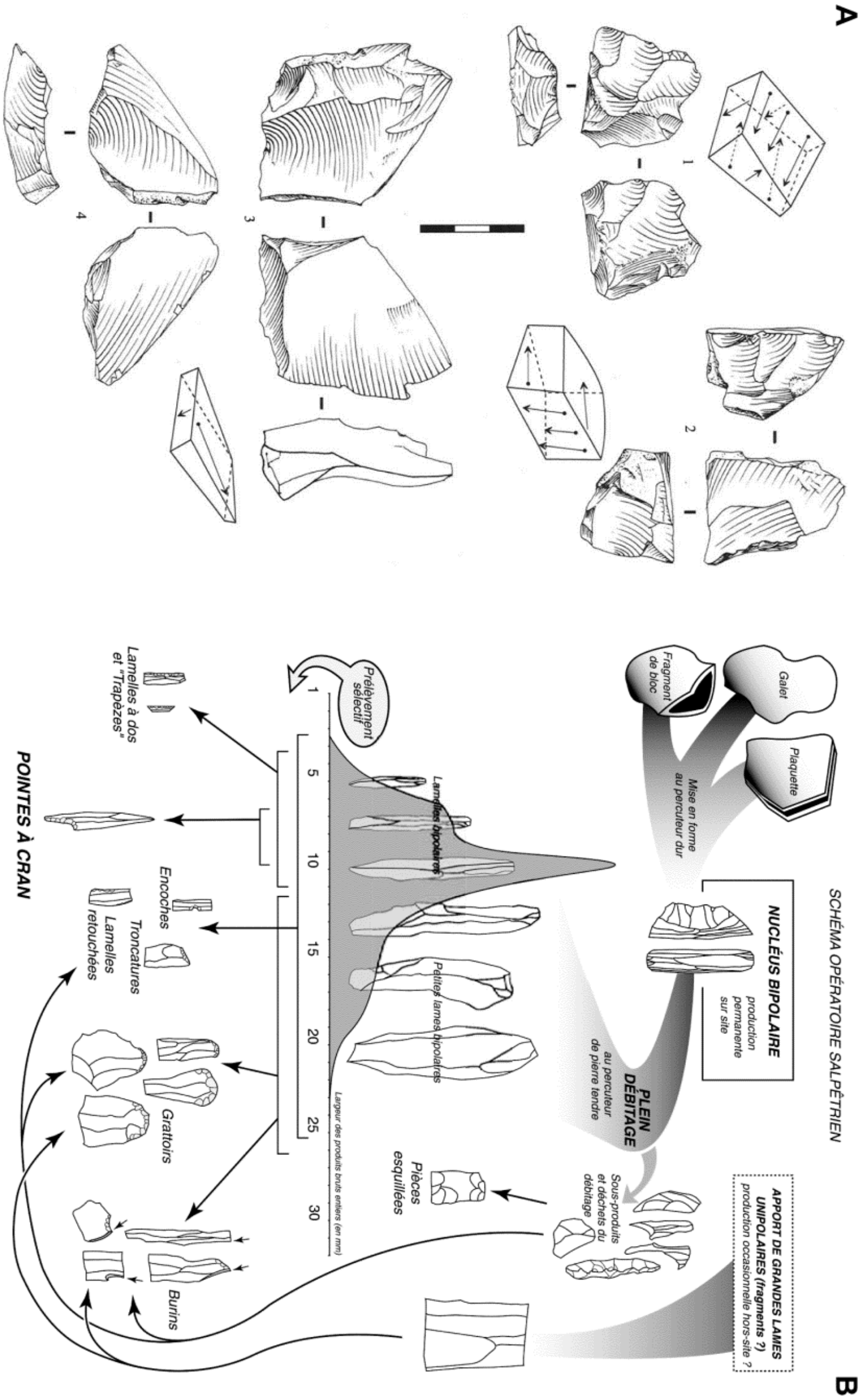


Fig. 8 **Two examples for the mobilisation of conceptual imagery in French lithic research. [A] Juxtaposition of three small flake-cores from Gouzeaucourt level G and their volumetric exploitation scheme (Soriano 2000: Fig. 100). Note that conceptual imagery is included here to supplement the informational value, to focalise the attention, and to present the results of reading each core's *schéma diacritique*; the resulting image is consequently hybrid. [B] Full-blown conceptual representation of the reduction scheme for the Early Sapletrian (Bazile and Boccaccio 2008: Fig. 26). The focus lies on the spatiotemporal articulation of artefacts and classes of artefacts within the global technical process. Note that this 'schematisation' of systemic technical relationships is the final lithic-related image in the paper.**

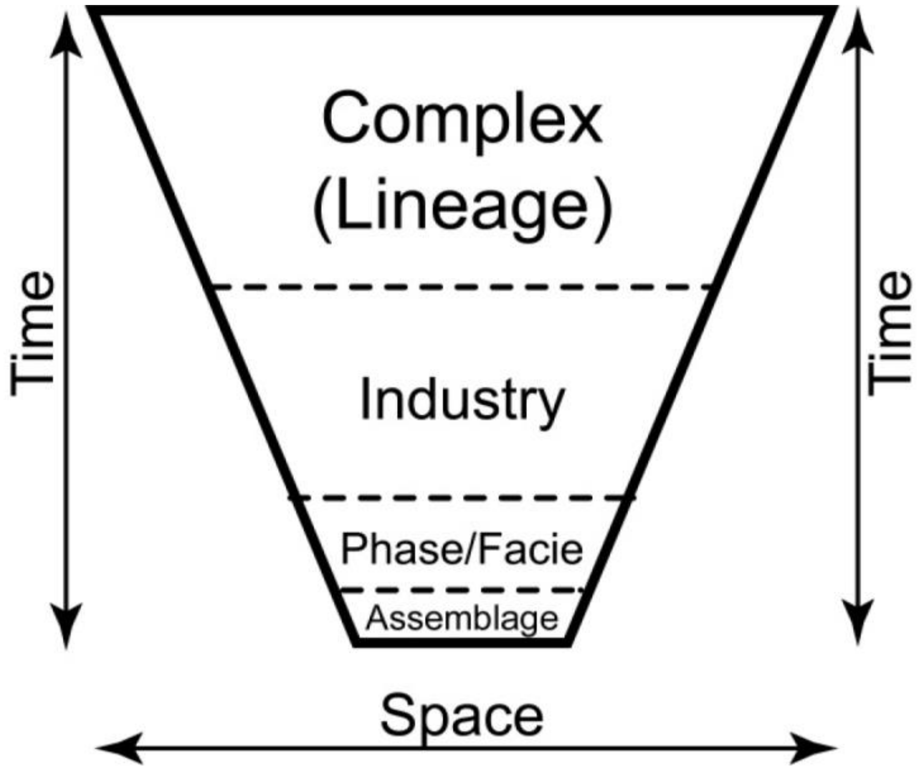


Fig. 9 **Example for the layered conceptualisation of lithic variability and the latter's interpretive significance (Williams 2003: Figure 4.1). Note that the vertical and horizontal axes of the schema not only signify the spatiotemporal extent of the various layers of lithic reality, but also the degrees and types of artefact-affinity required to identify them.**

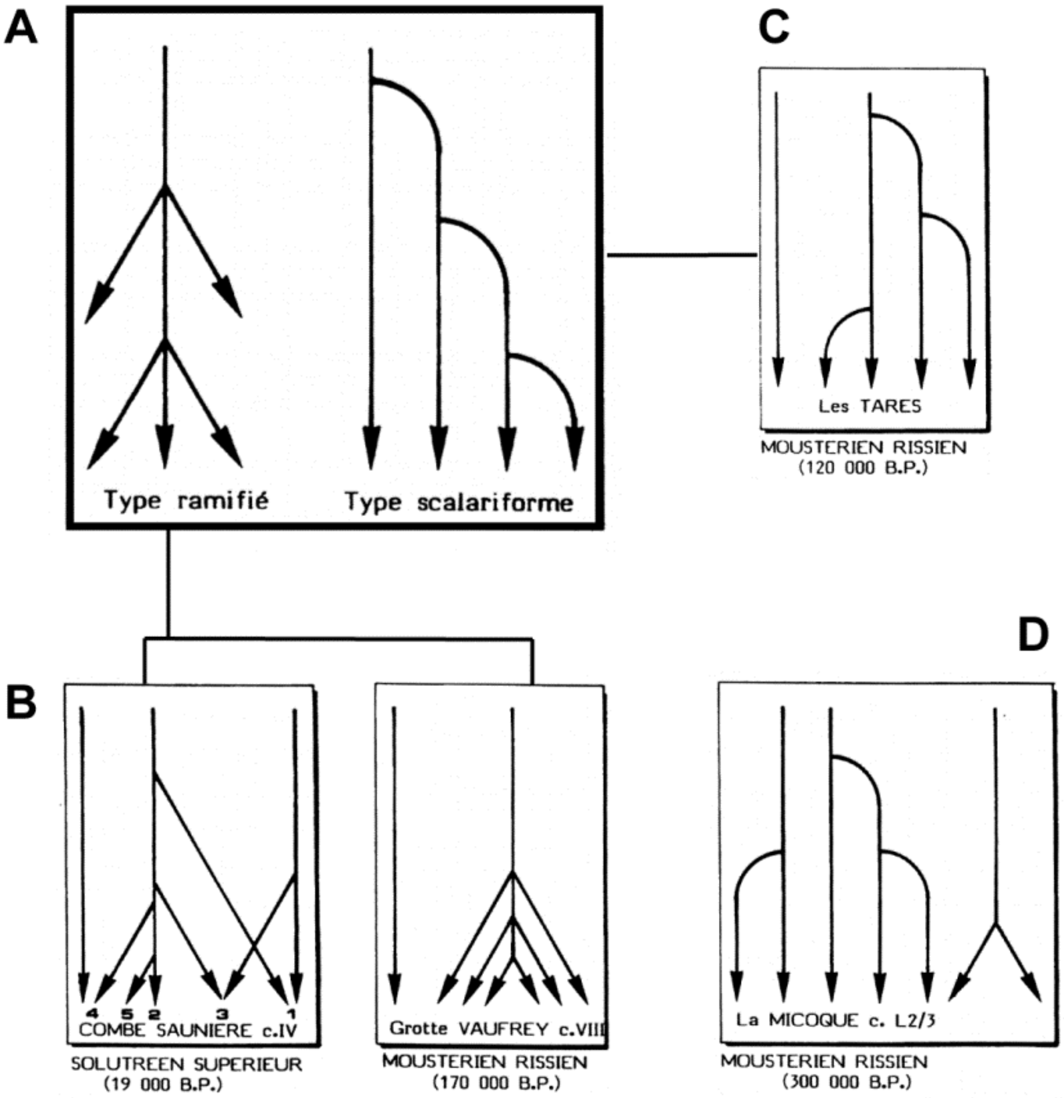


Fig. 10 **Example of 'visual reasoning' reflecting the structural conceptualisation of lithic complexity (modified after Geneste 1991 [2010]: Fig. 1). Note that the ideal-typical distinction between 'ramified' and 'scalariform' reduction structures in [A] may be differentially realised by specific lithic assemblages. [B] Two examples of strongly 'ramified' reduction sequences co-existing with a 'simple' and essentially 'linear' reduction sequence. [C] Example of a strongly 'scalar' reduction sequence similarly co-existing with a 'simple,' 'linear' reduction sequence. [D] Mixture of 'scalar' and 'ramified' reduction sequences. One may interpret this representation of reduction structures as an implicit quantification of complexity (e.g., one may count branching points and determine degrees of nestedness), but this 'quantitative' vision of complexity is of course *derived* - it depends on a basic qualitative understanding of the involved technical processes.**

Characteristic	Inclined	Parallel	Platform
Position of main removal surface(s)	Broad surface	Broad surface	Usually not on a broad surface
Geometry & number of faces	Volume defined by two surfaces	Volume defined by two surfaces	Volume defined by more than two surfaces
Angle of removals relative to the plane of intersection defined by the surfaces	Roughly 45°	Less than 30°	Not applicable
Removal angle relative to the striking platform	Not applicable	Not applicable	Greater than 45°
Orientation of removals on the main removal surface(s)	Converge toward the centre of the removal surface(s)	Multiple possibilities	Parallel
Origin of removals	All removals originate from the circumference defined by the intersection of the two surfaces	All removals originate from the circumference defined by the intersection of the two surfaces	Main removals from well defined striking platform(s)

Fig. 11 **Tabulation of three most important core taxa in the African Stone Age – *Inclined, Parallel,* and *Platform* – and their constitutional features (Conard et al. 2004: Table 1). Note that individual taxa are defined as distinct 'clusters of traits.'**

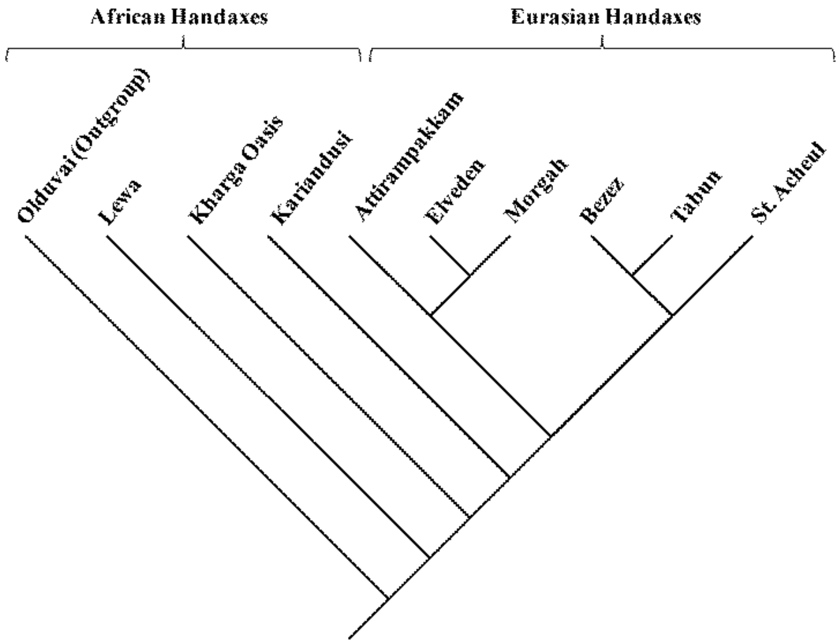


Fig. 12 **Lycett's (2009: Fig. 1) maximum parsimony tree based on 66 handaxe characters (Tree length = 1222). Note that 'phylogenetic' distance is calculated by arranging intra-assemblage variance from high to low; 'phylogeographic' patterning is checked by comparing the degree of fit between the effectuated arrangement and the actual distance of the assemblage-hosting sites from Africa.**

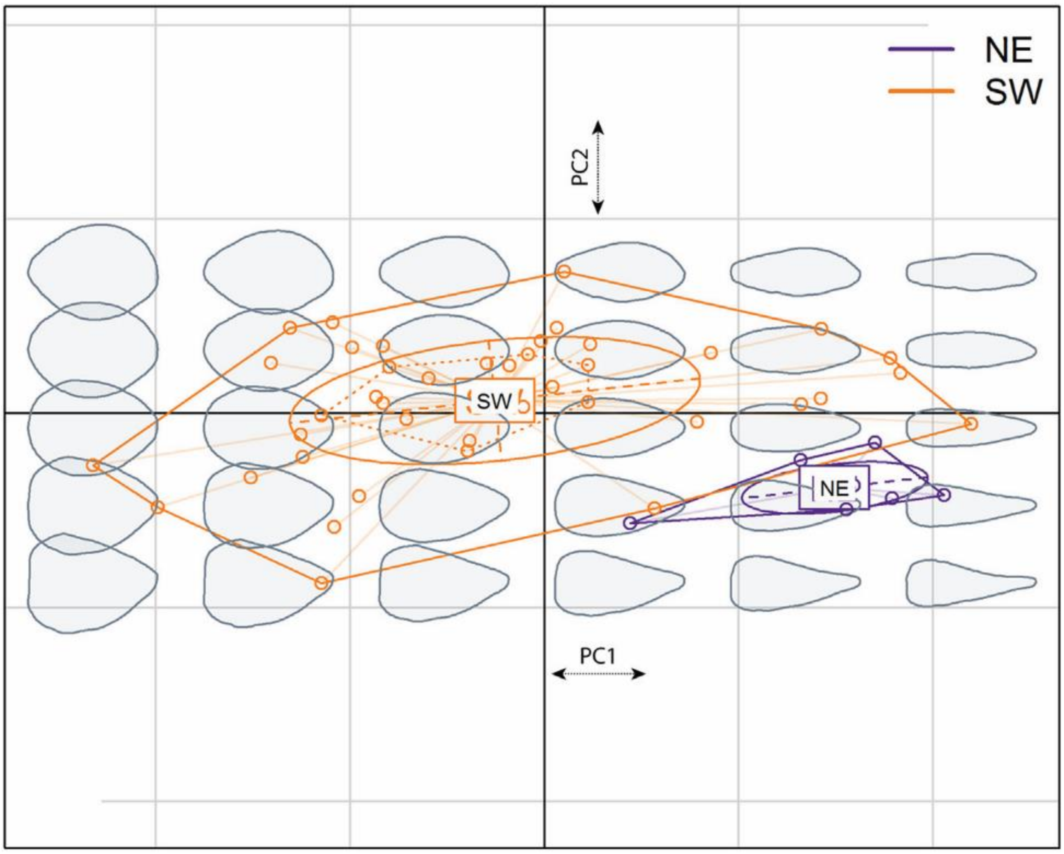


Fig. 13 **PCA plot of the 12 harmonic coefficients of Still Bay point shape (Archer et al. 2016: Figure 7). Contour lines represent idealised mean shapes from hypothesised states of 'low' reduction (left) to states of 'high/intensified' reduction (right). The general structure of point data from the two site clusters is shown to be distinct (almost no overlap on the first two principal components). Note that this logic of analysis is 'structuralistic' since two sets of inter-relationships are compared (shape, geographic), requiring a decomposition of both complex data-sets.**

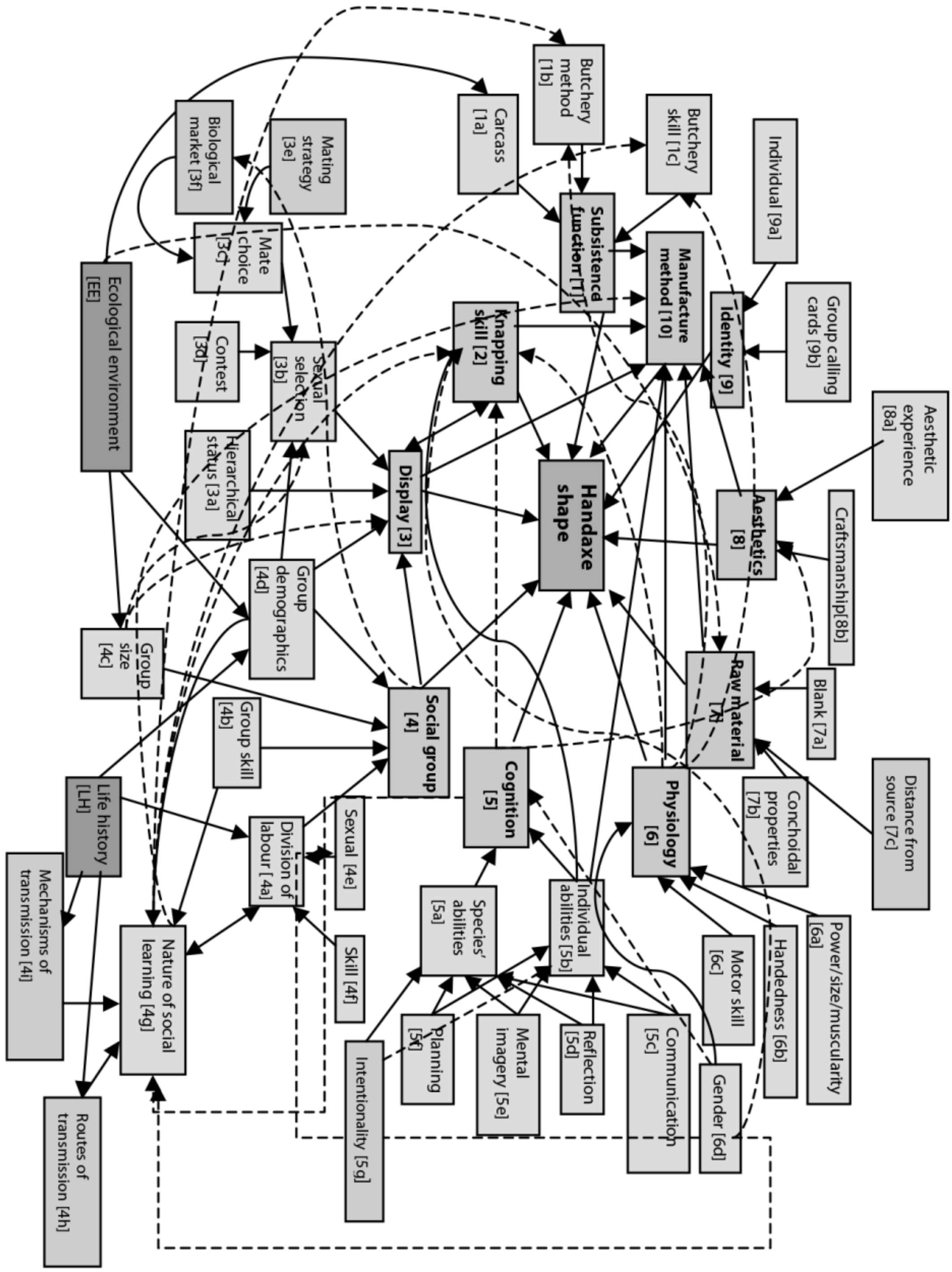


Fig. 14 **Complex flow chart of potential factors contributing to handaxe shape (Machin 2009: Figure 1). Note that the chart implicitly conceptualises handaxe-form as a 'mirror of a scaled reality.' This comes close to a 'contextualistic' assessment, but relies on somewhat 'fixed' categories which may or may play a role in observed processes of handaxe-making. Note also that "relationships of influence" are directed and symmetric interaction or proper co-constitution appears to be suspiciously absent: bi-face shape literally casts a "shadow."**

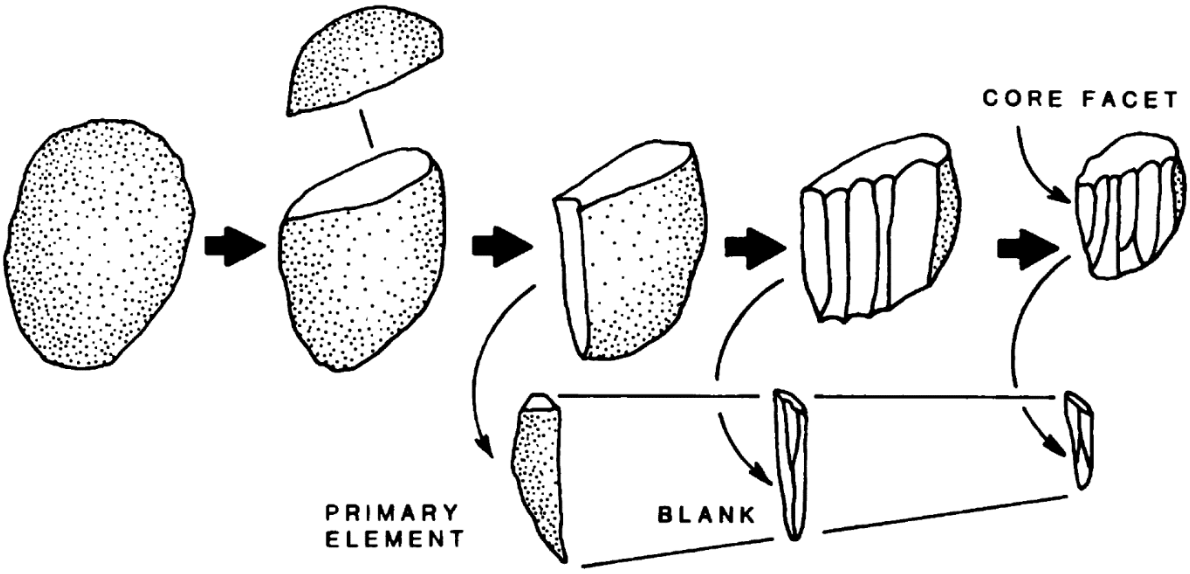


Fig. 15 **Schematic illustration of the basic principles of Henry's (1989b: Figure 1) dimensional reduction model. Theorised is the relationship between the size of preserved core-facets and blanks-size including cortex-cover; they are shown to depend on reduction depth and the 'life-history' of cores. The relationship can be used to explore the intensity of core reduction at specific locales and to investigate whether lithic artefacts seem to have been imported to an archaeological site (conversely, one may examine whether particular blank-types and –formats are "missing" from the site). Note that the model delineates generalised yet clear-cut expectations which can be compared to patterns observed in actual assemblages.**

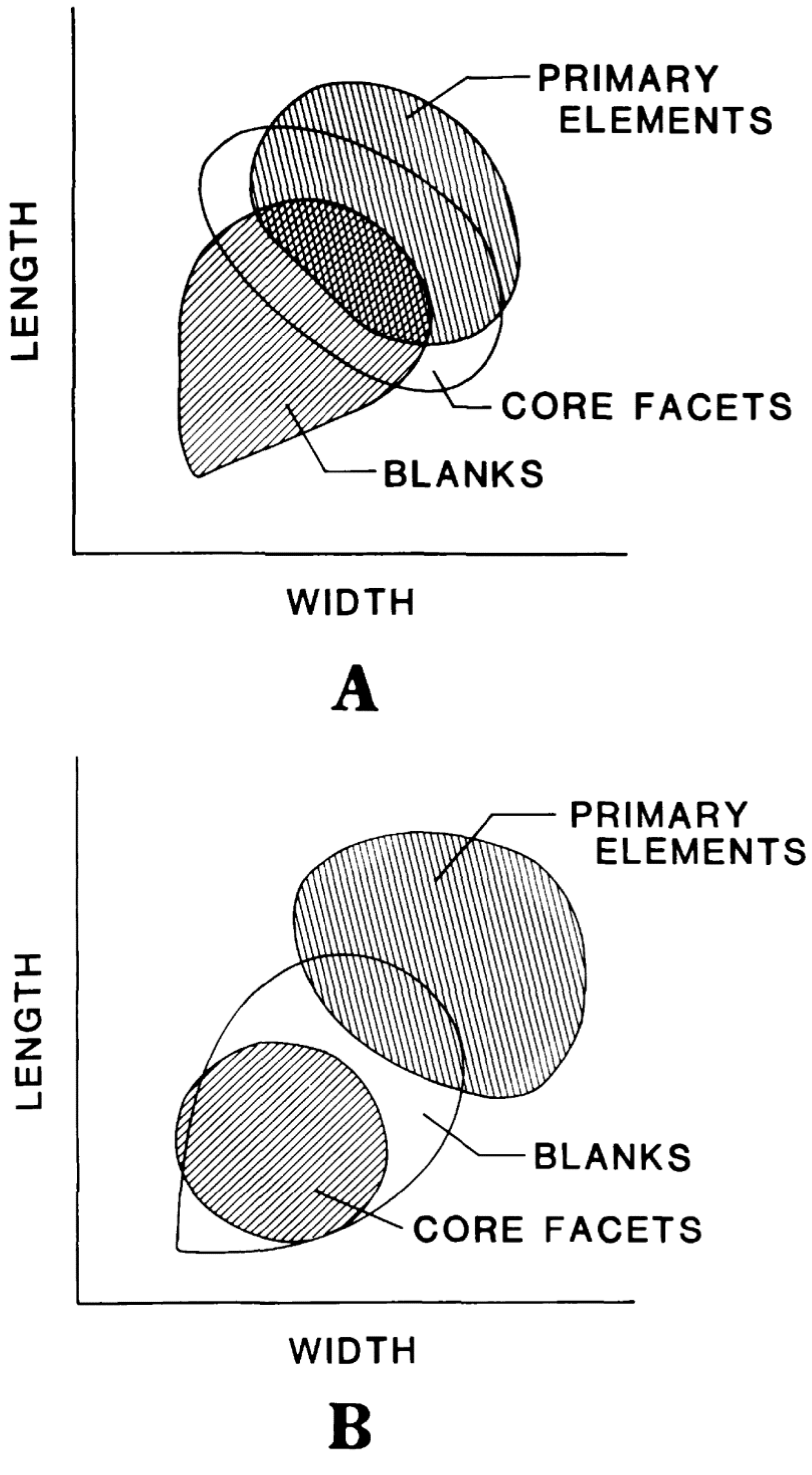


Fig. 16 **Schematic illustration of expected lithic patterns (Henry 1989b: Figure 2). The graphs exemplify two ideal-typical constellations of core-facet dimensionality, blank dimensionality, and the dimensionality of primary elements. The degree of overlap between these values allows to assess the local exhaustion of cores. Graph [A] describes a scenario of relatively low core-exhaustion, while graph [B] describes high levels of core-exhaustion. Note that this determination depends on the comparison of well-defined, generic, and generally 'fixed' artefact categories.**

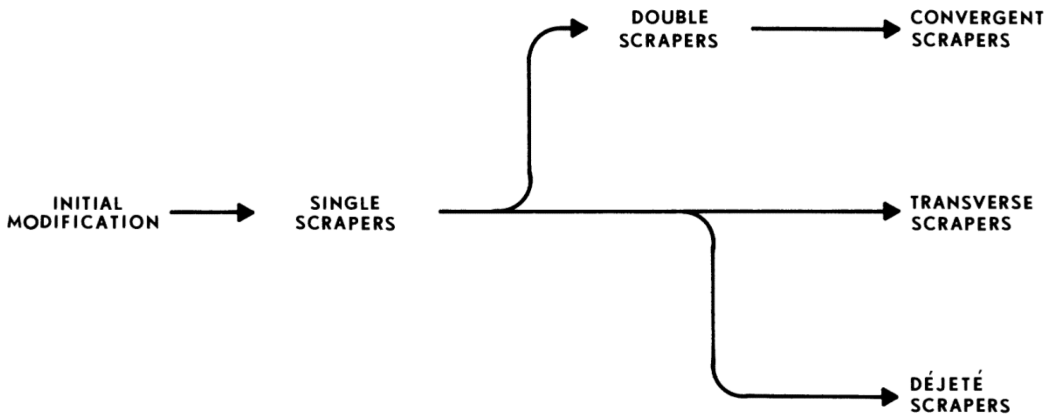


Fig. 17 **Directed flowchart representation of Dibble's scraper reduction model (Dibble 1987: Figure 4). The chart specifies distinct reduction trajectories and their typological consequences. Each 'type' occupies a distinct position in the wider 'field of locations' brought into existence by scraper reduction. Different groups of scraper types are consequently interpreted as manifestations of a generally continuous process of scraper transformation. The model highlight uni-directionality and the 'specifity' of reductional responses.**

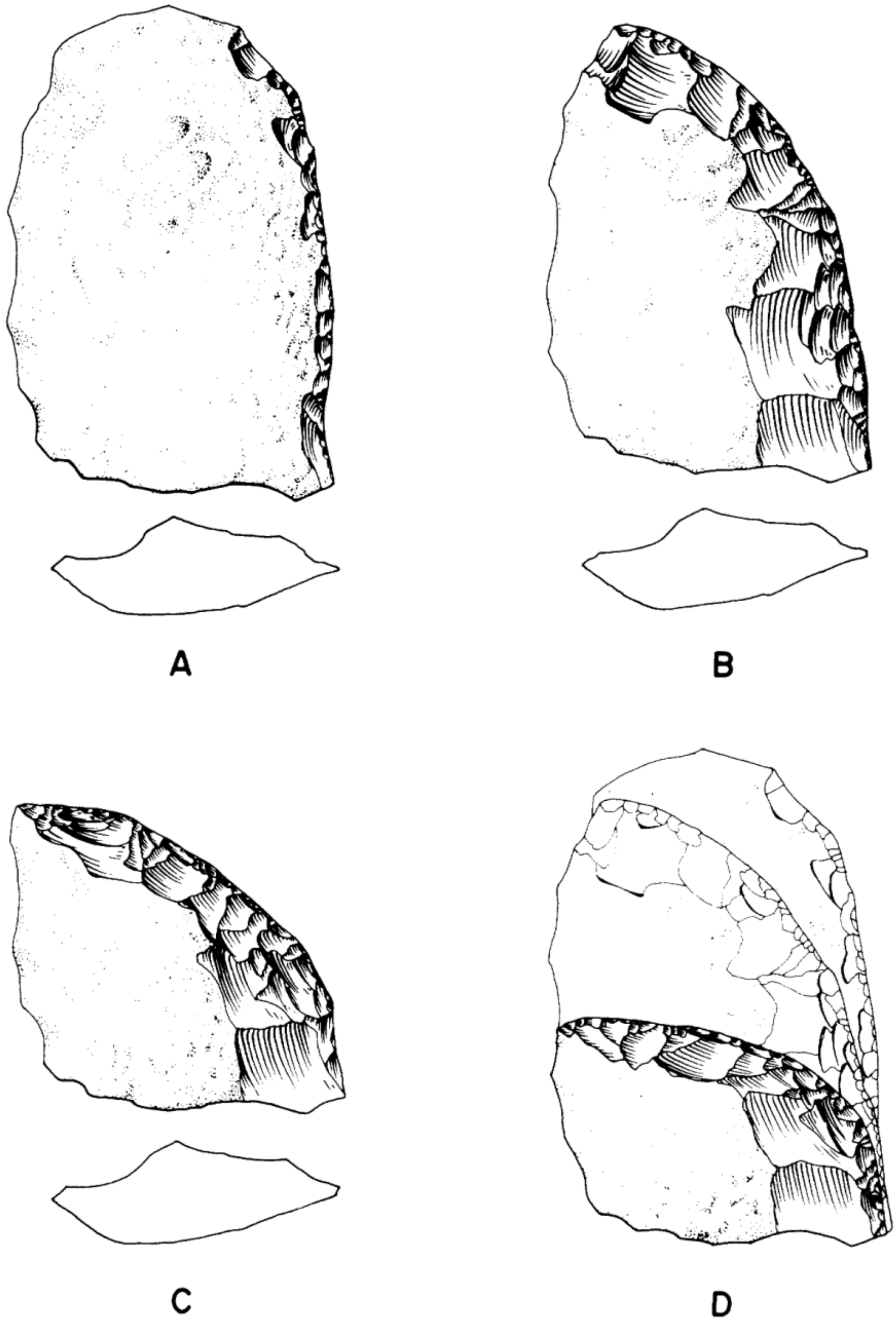


Fig. 18 **Experimental scraper passing through four continuous stages of reduction (from 'A' to 'D'); this process is irreversible and each state is fully determined by both its preceding state and the degree of raw material attrition caused by utilisation and/or reworking (Dibble 1987: Figure 2).**

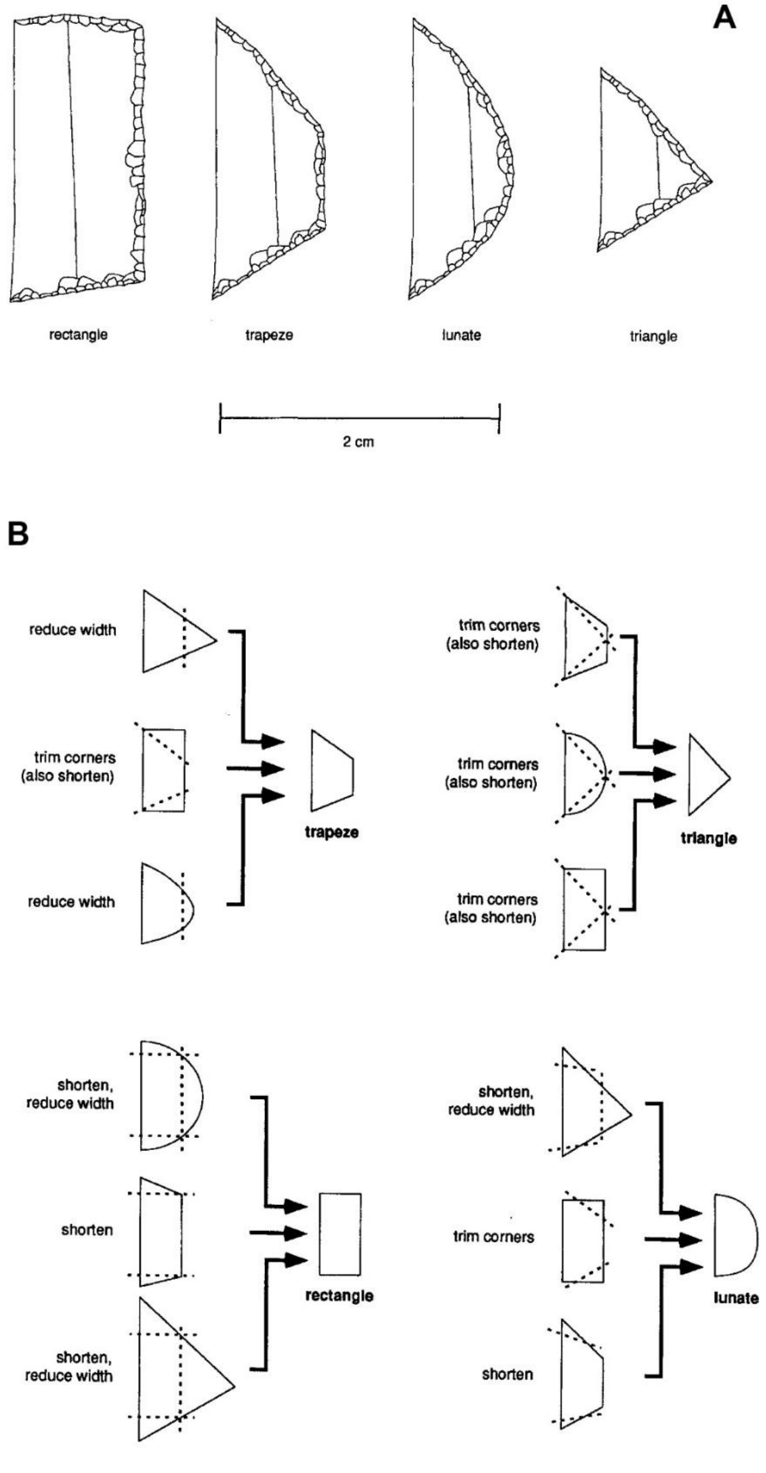


Fig. 19 **Neeley and Barton's (1994) model of microlith-reduction in the Near Eastern Late Palaeolithic and Epipalaeolithic. [A] exhibits the main types of geometric microliths which the authors have included in their model (Neeley and Barton 1994: Figure 7). Note that the order of types (from left to right) is roughly the trajectory of morphological transformation when more and more raw material is consumed. [B] theorises the 'effective chains' of lithic reduction leading to the observed microlithic types (Neeley and Barton 1994: Figure 8). Note that each chain specifies at least two 'physical events' and that the resulting lithic types are fully determined by the reductive events preceding them.**

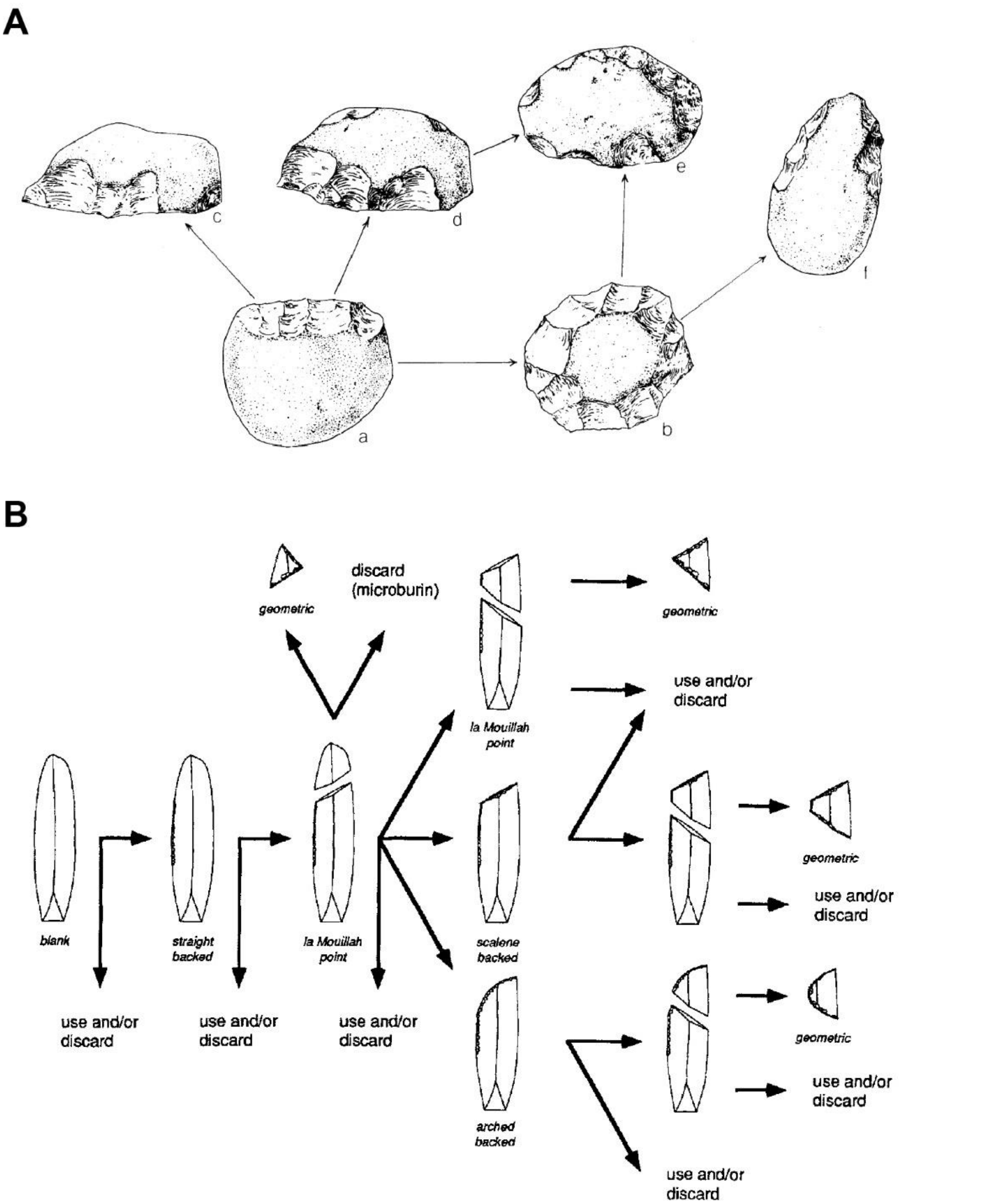


Fig. 20 **Two examples of flowcharts (digraphs) to visualise different trajectories of lithic transformation. [A] Pott's (1991: Figure 1) proposal that main artefact types in the Oldowan delineate a continuum of reduction. Although the graph is clearly directed, the implied 'equifinality' of the reduction background of object-class 'e' is noteworthy. [B] Neeley and Barton's (1994: Figure 6) reconstruction of the intercalated production trajectory for backed bladelets and geometric microliths. Again, the chosen mode of representation is a digraph specifying the key vectors of causal determination.**

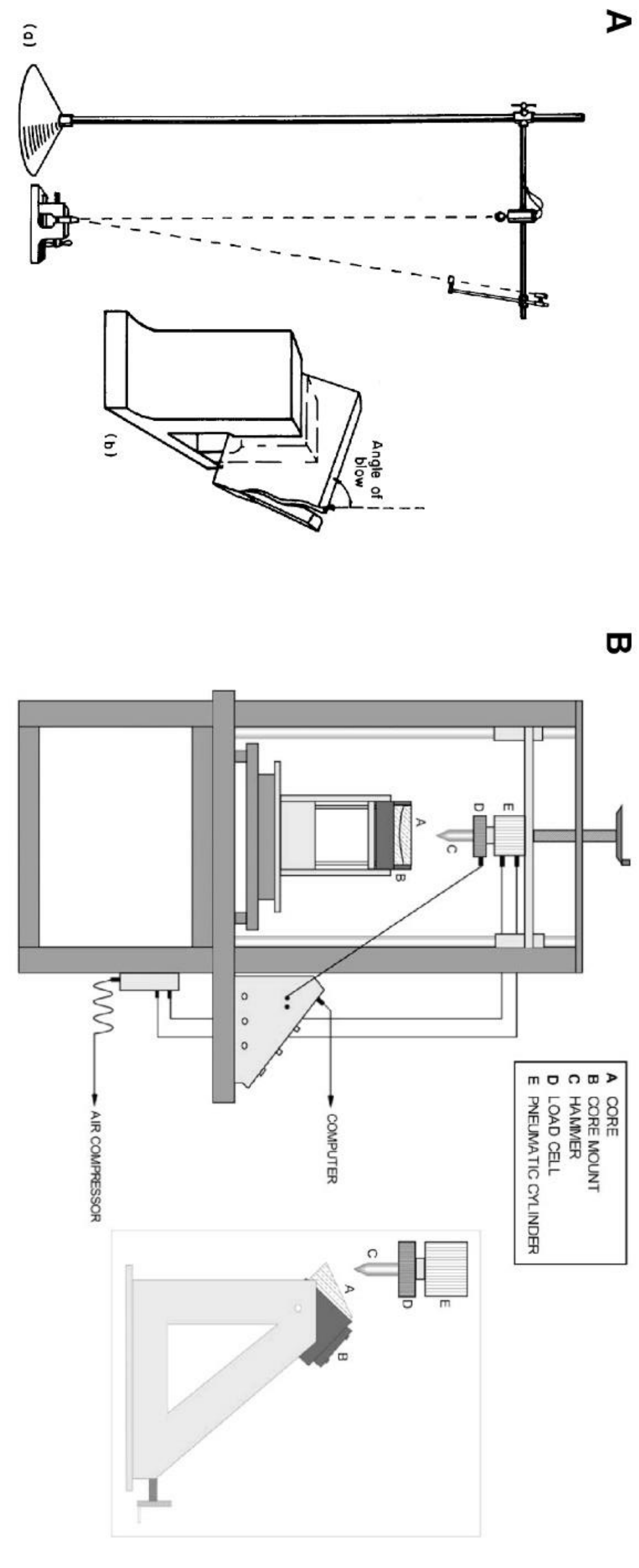


Fig. 21 **Example of the types of automated machinery used to conduct controlled lithic experiments. [A] Schematic overview of the experimental apparatus and glass core used by Dibble and Whittaker (1981: Figure 1) to explore the effect of exterior platform-angle on other flake attributes. [B] Schematic representation of the mechanical flaking apparatus introduced by Dibble and Rezek (2009: Fig. 3) to study and compare flake-formation processes.**

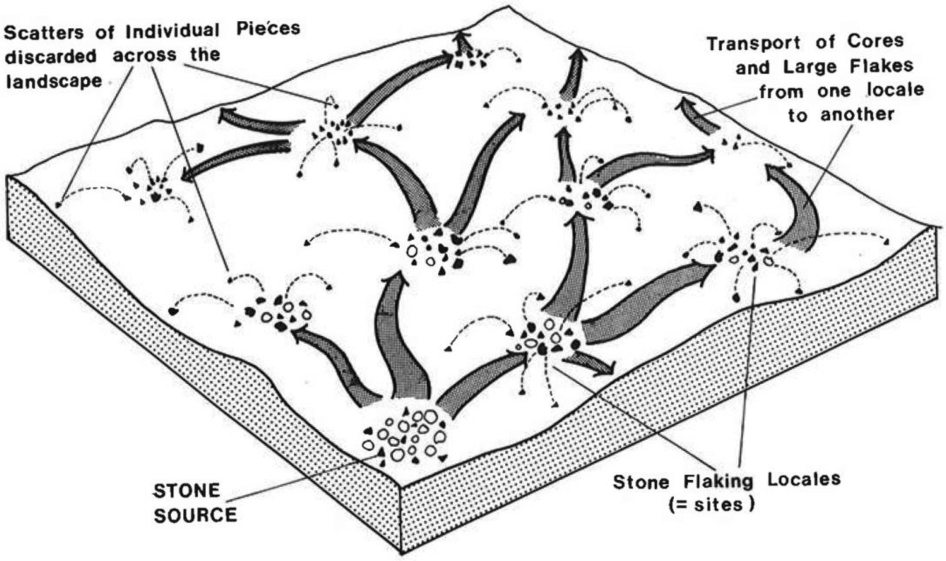


Fig. 22 **Causally-integrated land-use system of early hominins. The model revolves around artefact aggregations of various density and composition, rather than around "static" items or "fixed" toolkits. The resulting "veil of stones" is envisioned as the "fallout" of a complex system of lithic extraction, manufacture, transport, use, re-cycling, and eventual discard. The landscape defines the general framework in which a network of more or less well-delineated activity spheres emerges, each of which constitutes an 'effective' part or "node" of the total network (Isaac 1986: Fig. 15.6).**

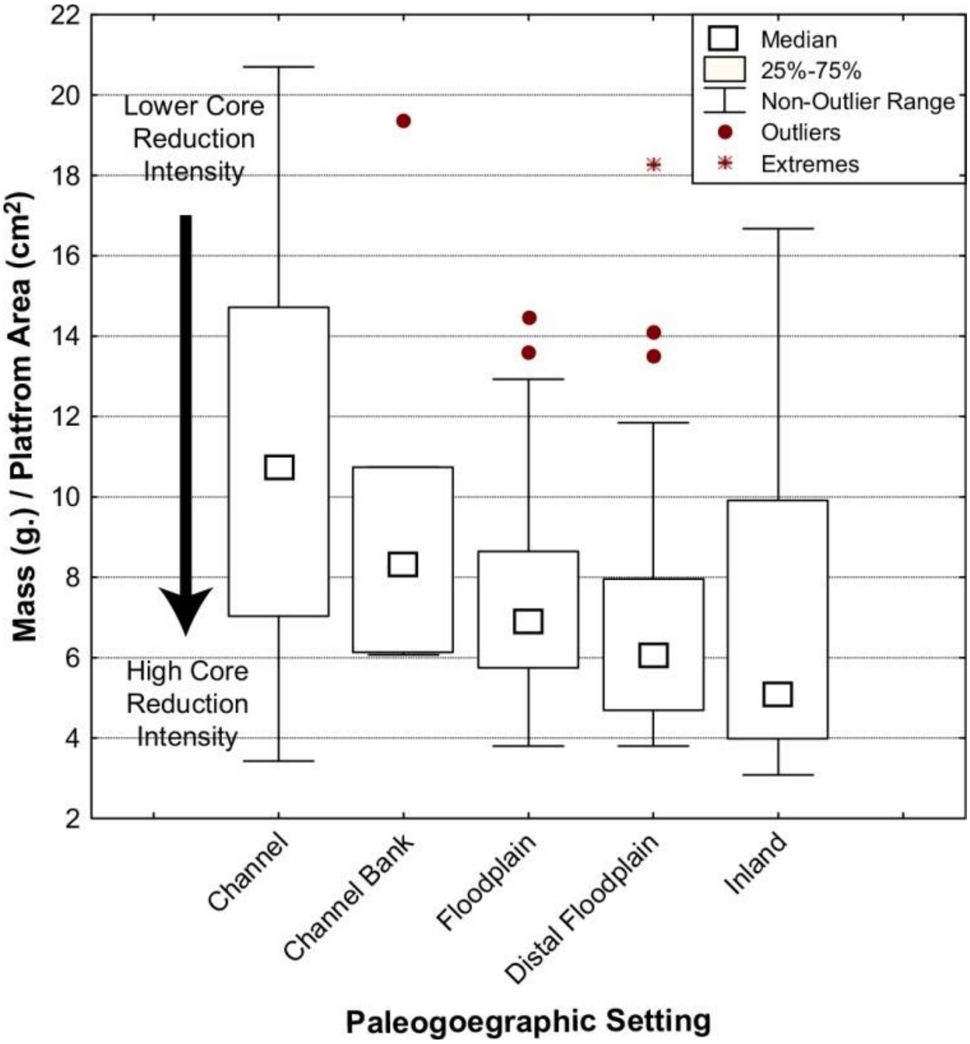


Fig. 23 **Braun et al.'s (2008a: Fig. 5) correlation of core reduction intensity (poxied by the ratio between single platform core-mass and relative platform area) and palaeogeographic location. The graph shows that core reduction intensity co-varies with ecological setting and thus appears to be controlled by varying habitat ecologies. The reasoning is 'integrative' since it places heavy weight on a single technological measure as well as 'externalist' since the measure is compared to a significant non-technological variable.**

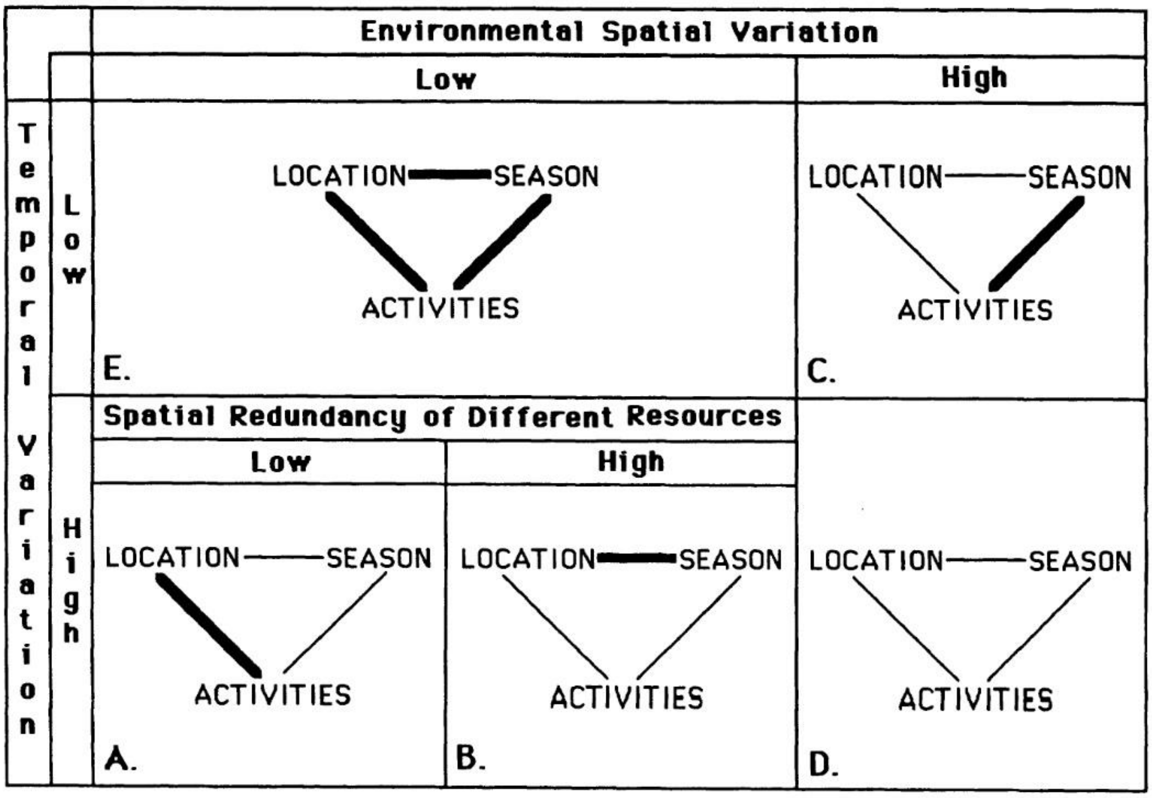


Fig. 24 **Jochim's (1991: Figure 1) five ideal-typical patterns of association between behavioural variables and environmental structure. *Location* refers to the placement of settlements/sites; *Season* refers to the period of occupation; *Activities* refer to the set of activities/behaviours documented at particular archaeological sites. Thick lines indicate key links of determination. Note that the resulting model is generalised and enables the deduction of particular expectations which can in turn be tested against the observable features of the archaeological record; it also emphasises hierarchies of constitution.**

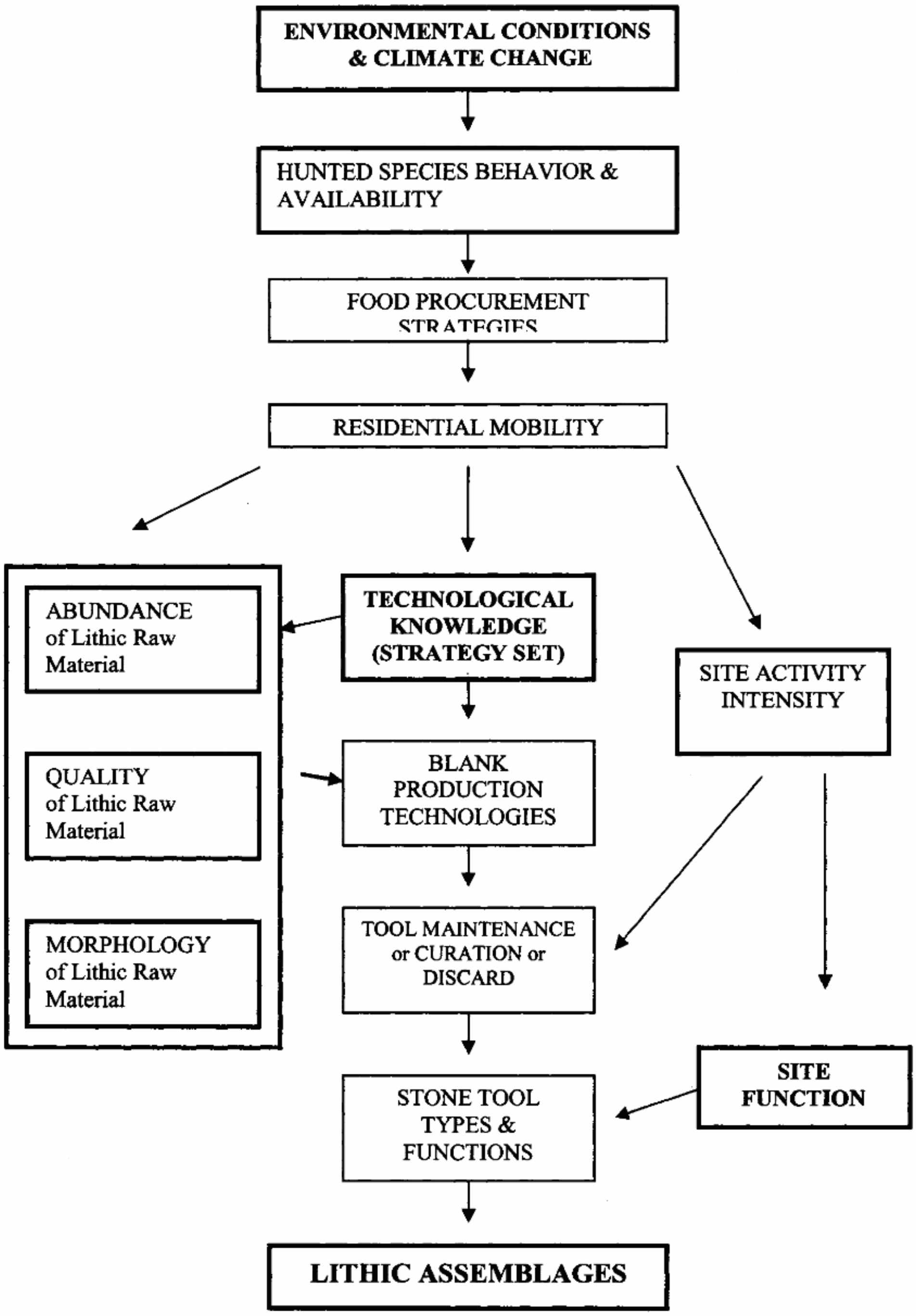


Fig. 25 **Effective chain of determination leading from particular environmental conditions to specific lithic assemblage characteristics (Steenhuyse 2007: Fig. 1.1). Note the presumed 'hierarchy of causation' and the implicated notion of lithic assemblages as 'derived' phenomena.**

Table 9.1 Hypotheses considered here and their empirical consequences.

Hypothesis	Overall size	Tool: blank size difference	Technological composition
1. Blank portability	Non-locals smaller	Similar for locals and non-locals	Non-locals less diverse
2. Distance attrition	No necessary difference	Less among non-locals	No necessary difference
3. (1) and (2) combined	Non-locals smaller	Less among non-locals	Non-locals less diverse

Fig. 26 **Cole's (2009: Table 9.1) three strategic options to solve the economic problem of lithic technology. Each solution gives rise to a well-defined hypotheses of economic functioning which can be tested against the lithic evidence. The table theorises the varying effects of the three economic strategies (primarily in terms of artefact dimensionality and raw material diversity). Note that the relevant facts are specified according to generalised theory of economy and that the lithic facts which are not relevant to this theory are not considered (that is, "explained away" by the theory). The main purpose of the tabulation is to establish clear-cut 'if-then' relationships of predictive significance.**

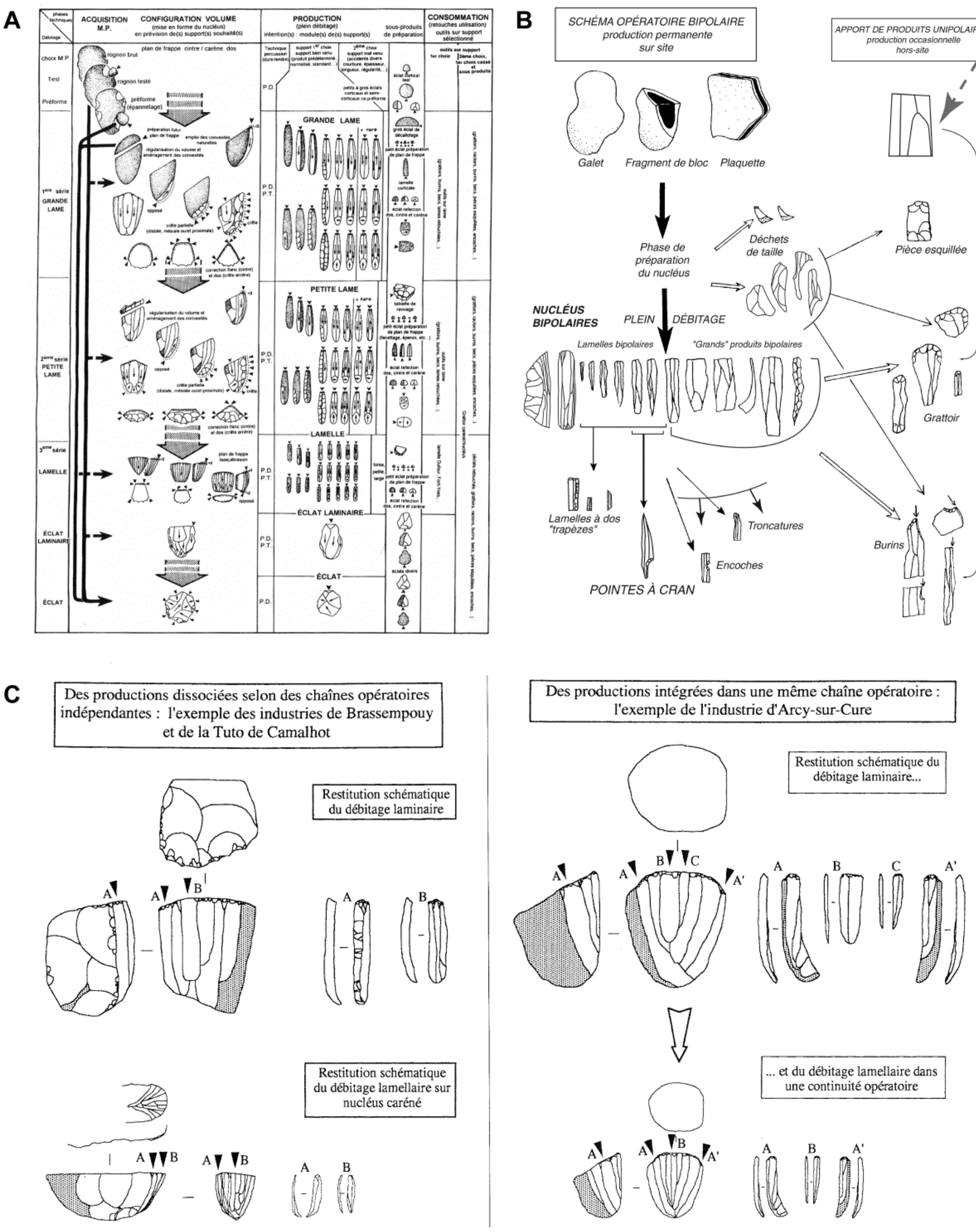


Fig. 27 **Reconstructed operational schemes of the Aurignacian and Salpetrian. [A] Global representation of the *chaîne opératoire* of the « *Aurignacien ancien* » in the South-West of France (Le Brun-Ricalens 1993: fig. 9). [B] Generalised operational scheme of the « *Salpêtrien ancien* » from the Languedoc region (Boccaccio 2005: Figure 159); note in particular the postulated (non-linear) relationships between sets of blanks and tool-types. [C] Comparison between systems of blade/let production in the Aurignacian of Tuto de Camalhot (left) and Arcy sur Cure (right) (Bon 2002: Fig. 78); note that the technical system on the left is characterised by two 'separated' *chaînes opératoires* (core-blade vs. carinated piece-bladelet), while the system on the right reveals the 'integrated' production of blades and bladelets, a distinction that Bon (2000, 2002) has used to discuss the difference between the Early Aurignacian and the Protoaurignacian in the region. Note also that the webs of technical relationships encapsulated by these operational schemes depend entirely on the inferred interrelationships between the respective lithic artefacts and groups of lithic artefacts.**

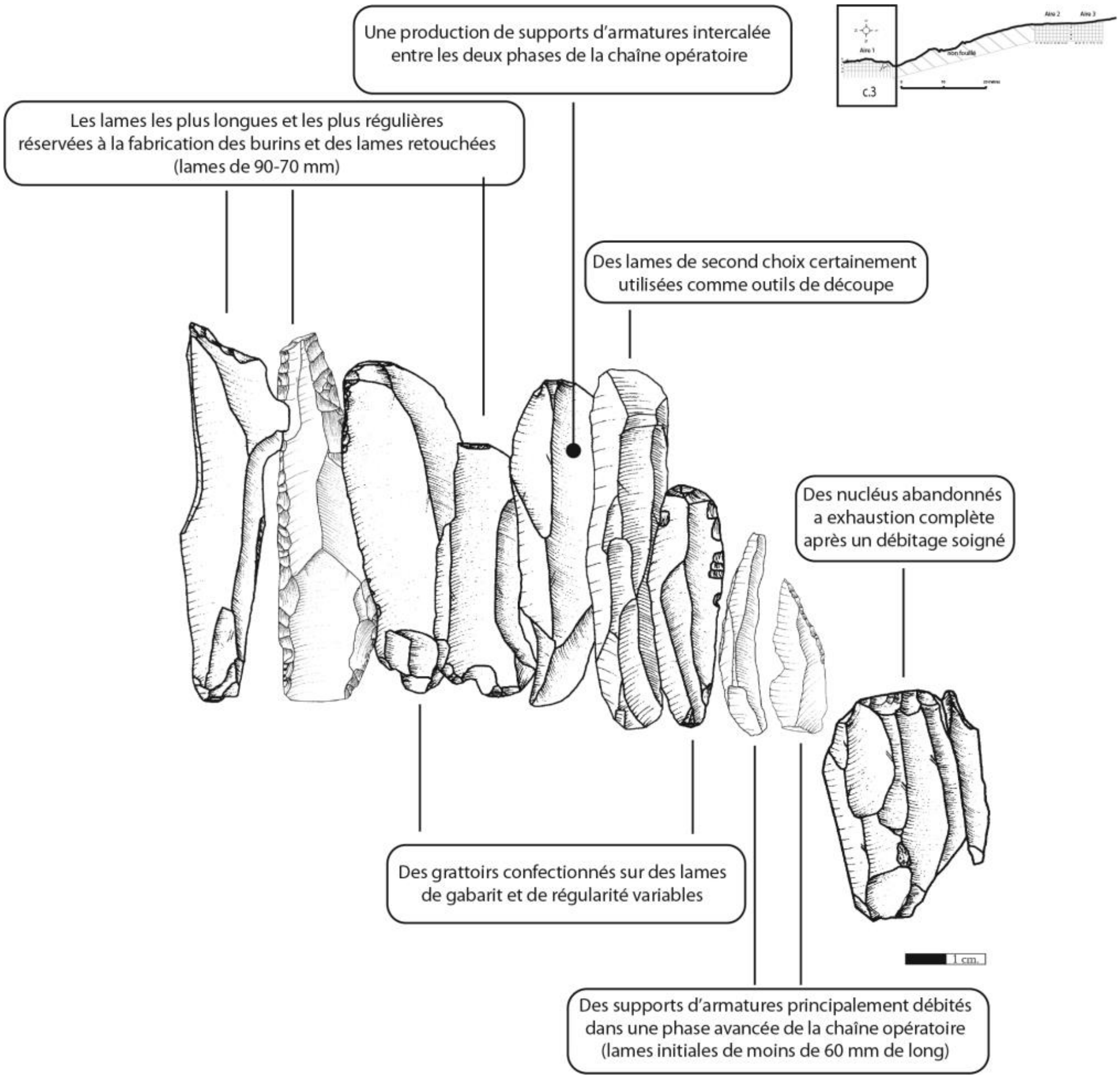


Fig. 28 **Synthetic representation of the reduction sequence of the « *Azilien ancien* » from the Abri de la Fru, couche 3, aire 1 (Mevel 2013: Fig. 6). Note that the different kinds of blanks that arise during the reduction process are shown to participate in different tool-sets. The treatment of blanks is hence related to the place and role of blanks in the wider *chaîne opératoire* (including the specific morphometric and technical characteristics that follow from it).**

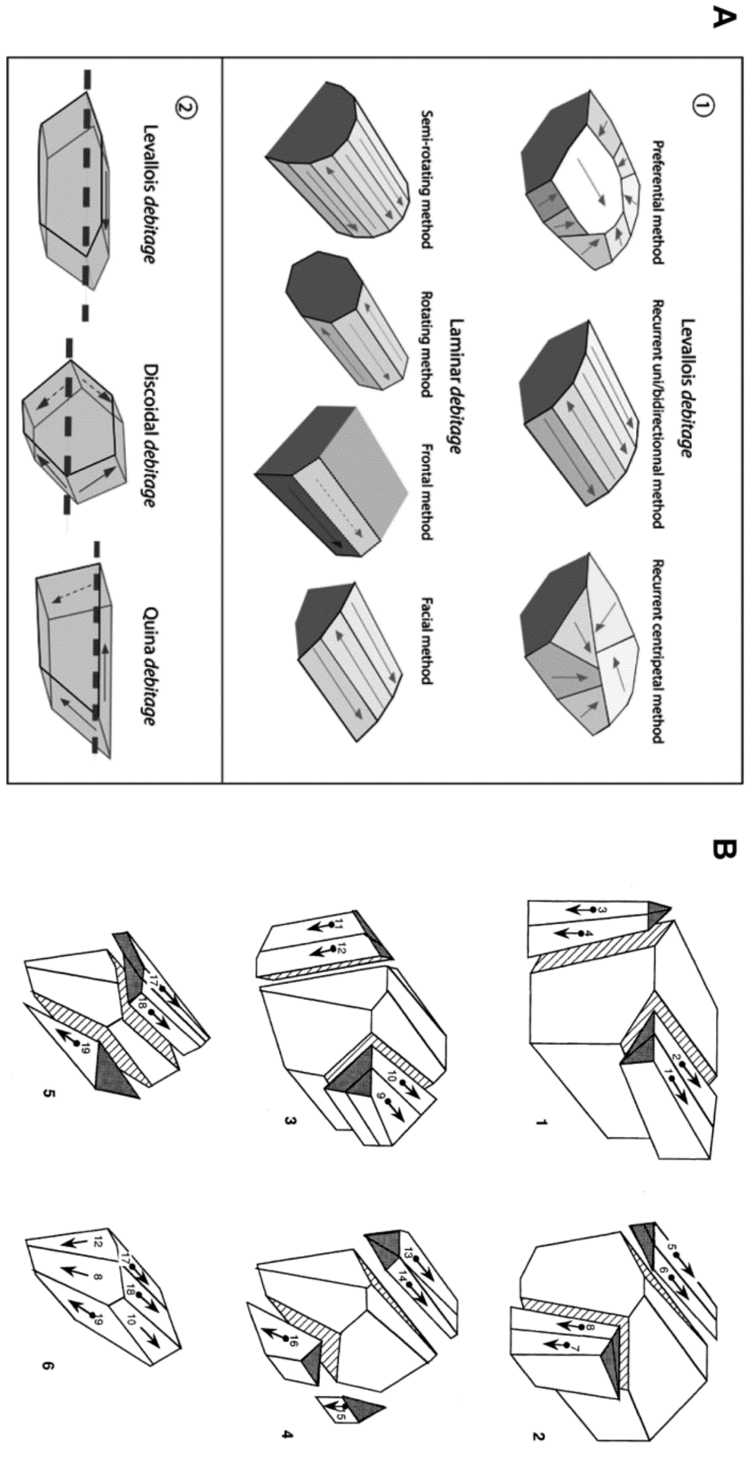


Fig. 29 **Schematic representation of the different volumetric conceptions characteristic for the Central and Western European Middle Palaeolithic. [A] Different methods of Levallois and laminar reduction (top) and volumetric architecture of the three main technical systems (bottom) of the Mousterian complex (Delagnes and Meignen 2006: Figure 1). [B] Principle of volumetric exploitation specified by the Quina method (Inizan et al. 1999: Fig 54; after Bourguignon 1997). Note that these examples employ 'volumetric schematisation' in order to visualise the technological management of core volumes – they encapsulate what may be called 'volumetric reasoning.'**

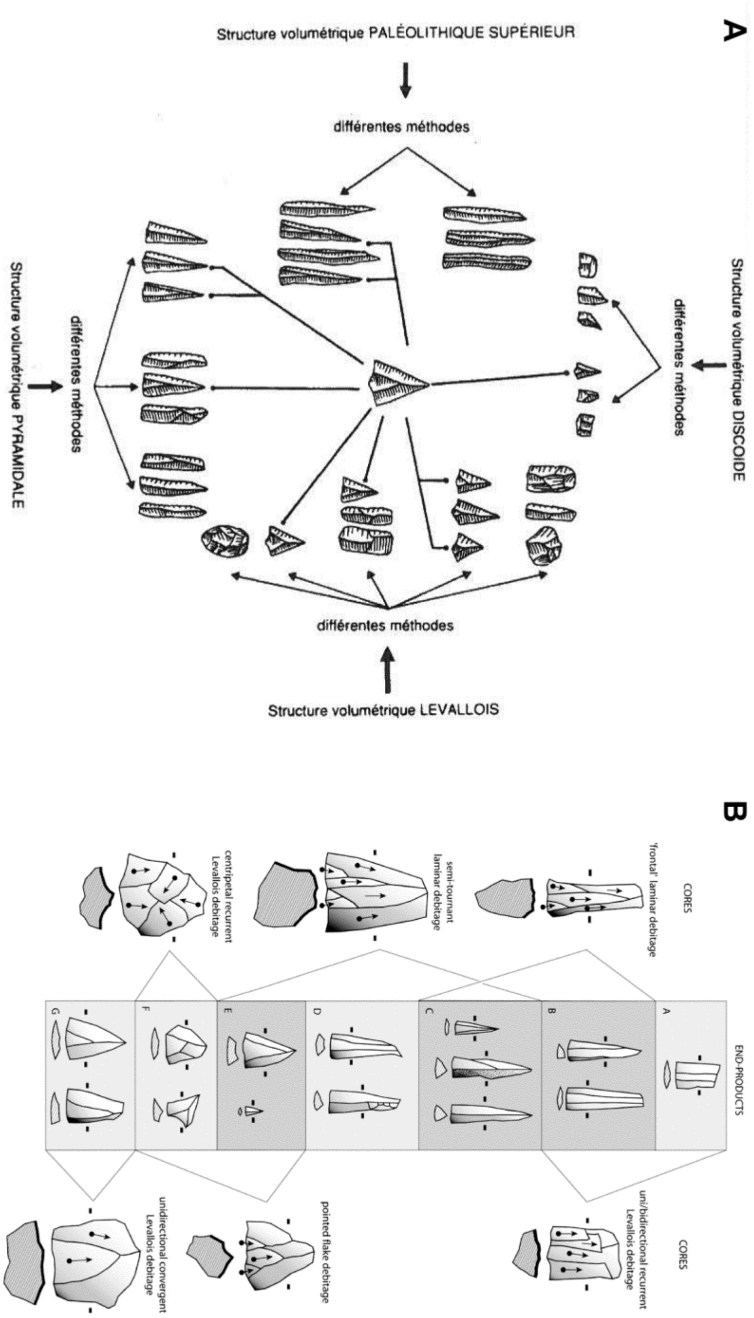


Fig. 30 **Schematic representations of systemic artefact relationships emphasising the 'polyvalency' of lithic 'morpho-types.' The shown diagrams demonstrate that similar shapes may occur in different technical system and may easily derive from different core architectures. [A] showas that multiple technical systems are capable to generate blanks that exhibit strong morphological affinities with an ideal-typical Levallois point (Boëda 1994: Fig. 177); yet, the diagram also indicates that these blanks occupy different positions within their respective technical context. [B] makes a similar point: it reveals that different Middle Palaeolithic technologies of Southern Arabia regularly produce the same types of blanks (Delagnes et al. 2012: Figure 9); taken in isolation, blanks are therefore a highly polyvalent category and should not be taken at face value. [A] and [B] suggest that 'morpho-types' can only be reliably interpreted if the relational infrastructures of lithic assemblages are described and disentangled.**

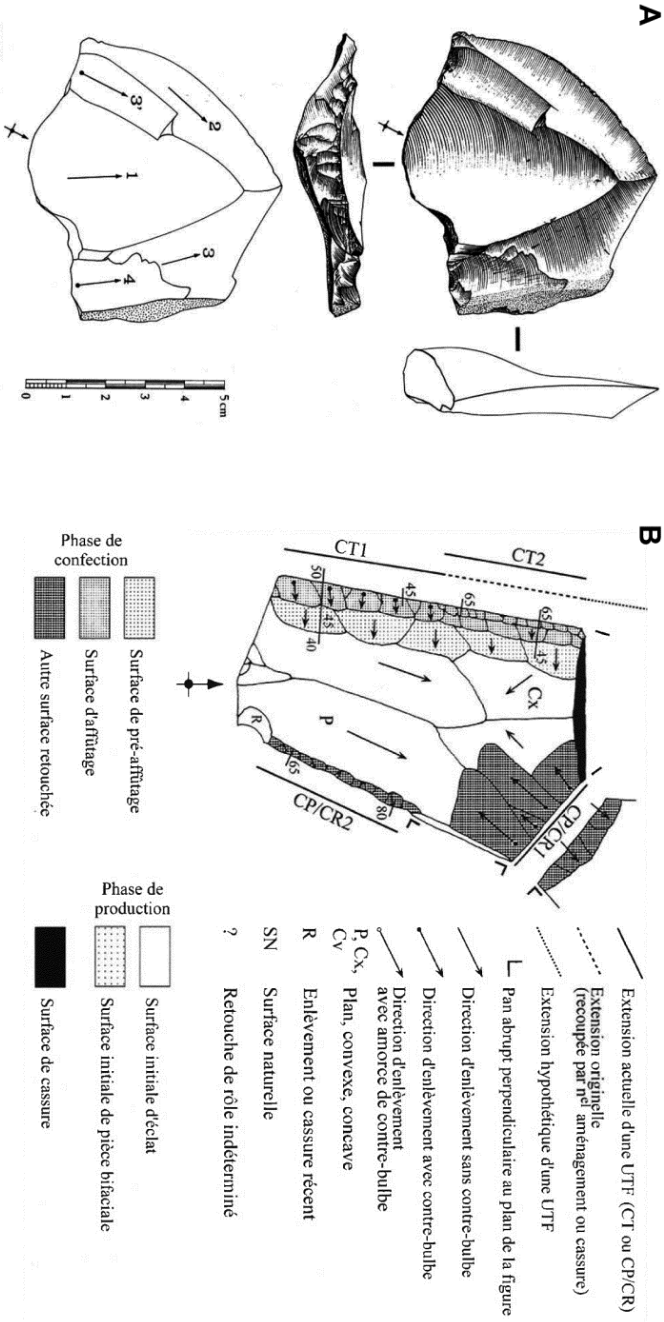


Fig. 31 **Two examples of applied *schémas diacritiques*. [A] Drawing (top) and *schéma diacritique* (bottom) of a Levallois point from the Erq el-Ahmar collection of Neuville (Dauvois 1976: Figure 51); arabic numbers denote the order and direction of the dorsal detachments. Note also the offset between the symmetry-axis of the blank and the axis of the original blank-removal. [B] Example of a complex *schéma diacritique* of a flake-tool with an emphasis on its techno-functionality, including a sample of the employed representational conventions (Soriano 2000: Fig. 138). [A] and [B] reveal that *schémas diacritiques* make visible the inter-relationality of the various technical dimensions of the objects they address. The development of symbolic languages and systems of technological coding plays an important part in this process. *Schémas diacritiques* expose what it means to 'read' lithic objects and lay bare that they are studied as *relational wholes* rather than as compositional entities.**

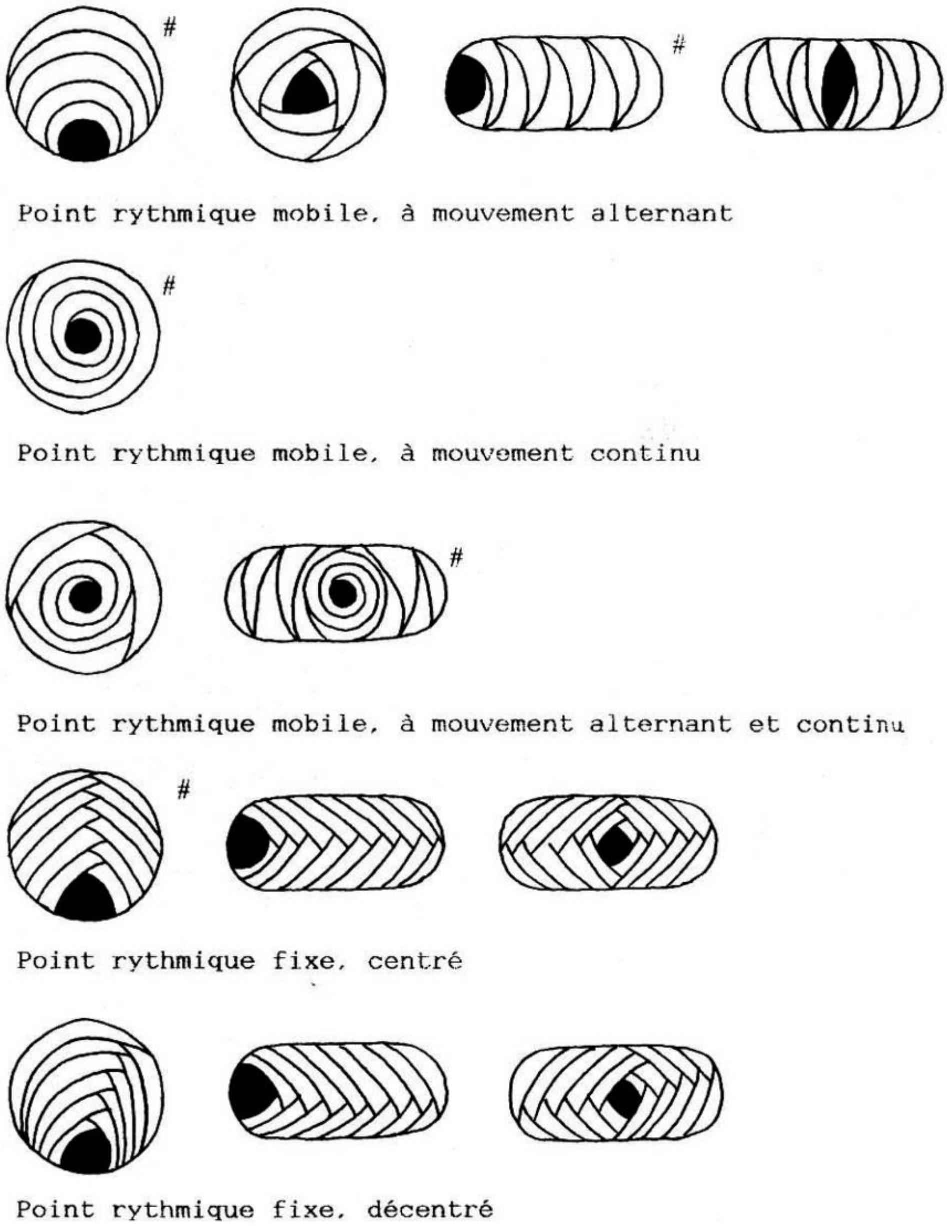


Fig. 32 **Various ways of organising lithic knapping resulting in distinct trajectories of blank-removal. The shown options, originally discussed by Ploux (1988: Fig. 26) in the context of the Late Magdalenian of Pincevent, reflect distinct modalities of handling a core matrix bound to different technical gestures and varying rhythms of knapping. Note in particular the distinction between 'fixed' and 'mobile/rotating' knapping centroids.**

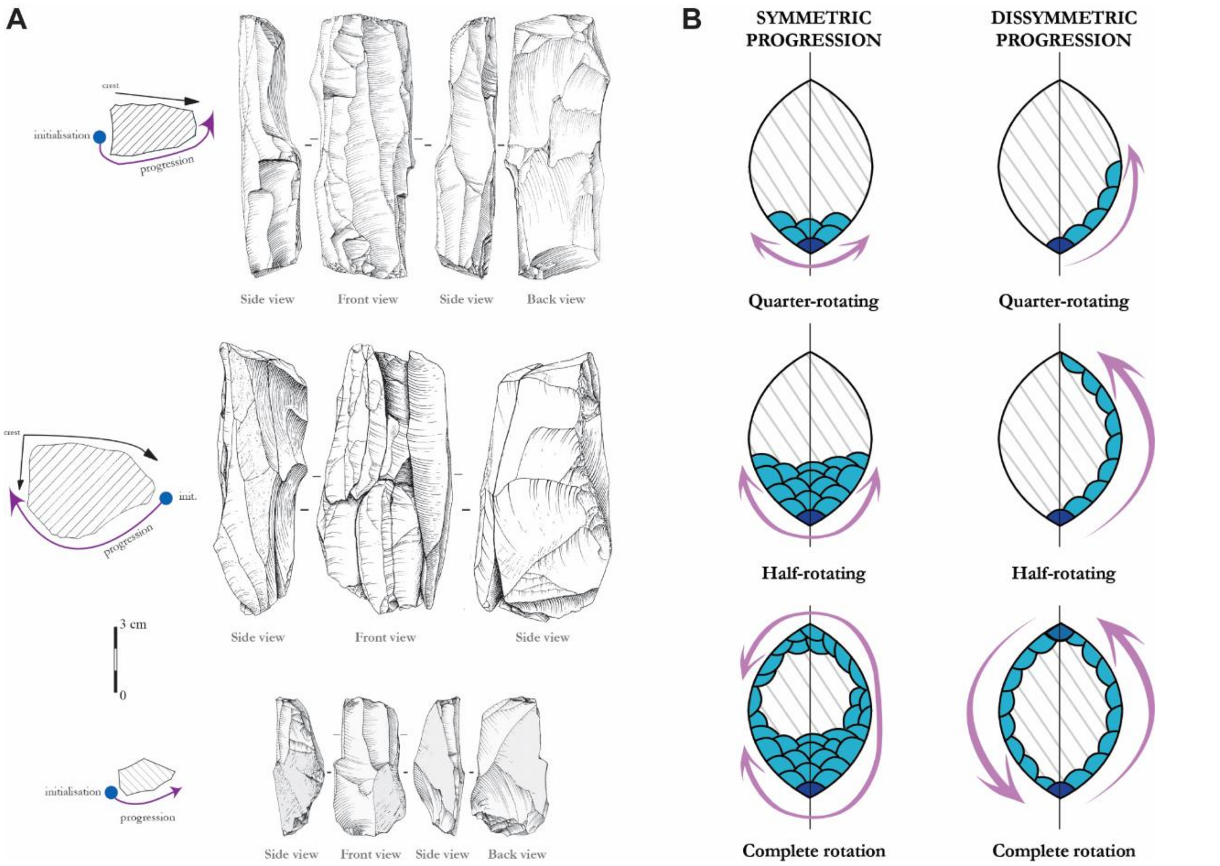


Fig. 33 **Technological analysis of knapping rhythms in a Late Upper Palaeolithic context. [A] Reconstructed spatial trajectory of knapping procedures in the Belloisian of Donnemarie-Dontilly (locus 4), revealing a dissymmetric progression of core reduction on tertiary flint (Valentin et al. 2014: Fig. 12). [B] Classificatory scheme employed to examine differences and similarities in *débitage* rhythm (Valentin et al. 2014: Fig. 7). Note that the spatiotemporal vectors of removal are taken to indicate particular interaction dynamics between a core and its embodied knapper. Note also that similar core cross-sections may give witness to dissimilar knapping rhythms. The study of knapping rhythms is thus yet another attempt to address the 'problem of polyvalency' in lithic technology.**

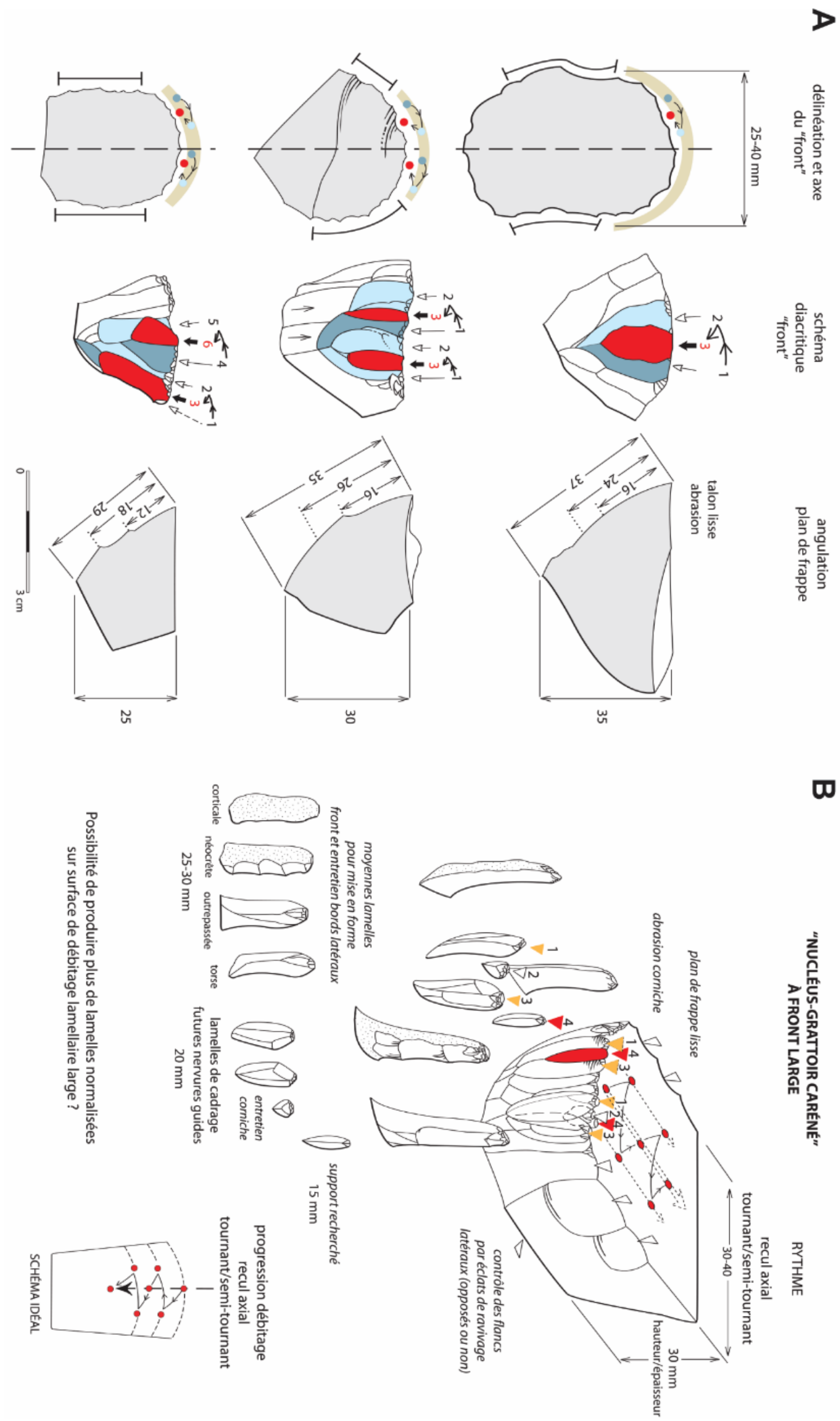


Fig. 34 **Technological analysis of knapping rhythms in a Early Upper Palaeolithic context. [A] *Schéma diacritique* of three carinated scraper-cores (« *nucléus-grattoir caréné* ») from the Aurignacian of Hui (Beauville, France) (Le Brun-Ricalens 2005: Fig. 9). [A] Generalised production scheme for small bladelets of various size and shape retrieved from carinated scraper-cores with large front at the same site (Le Brun-Ricalens 2005: Fig. 15). Note that the reconstructed 'geography' of reduction is interpreted as evidence for a highly specific and standardised rhythm of core exploitation.**

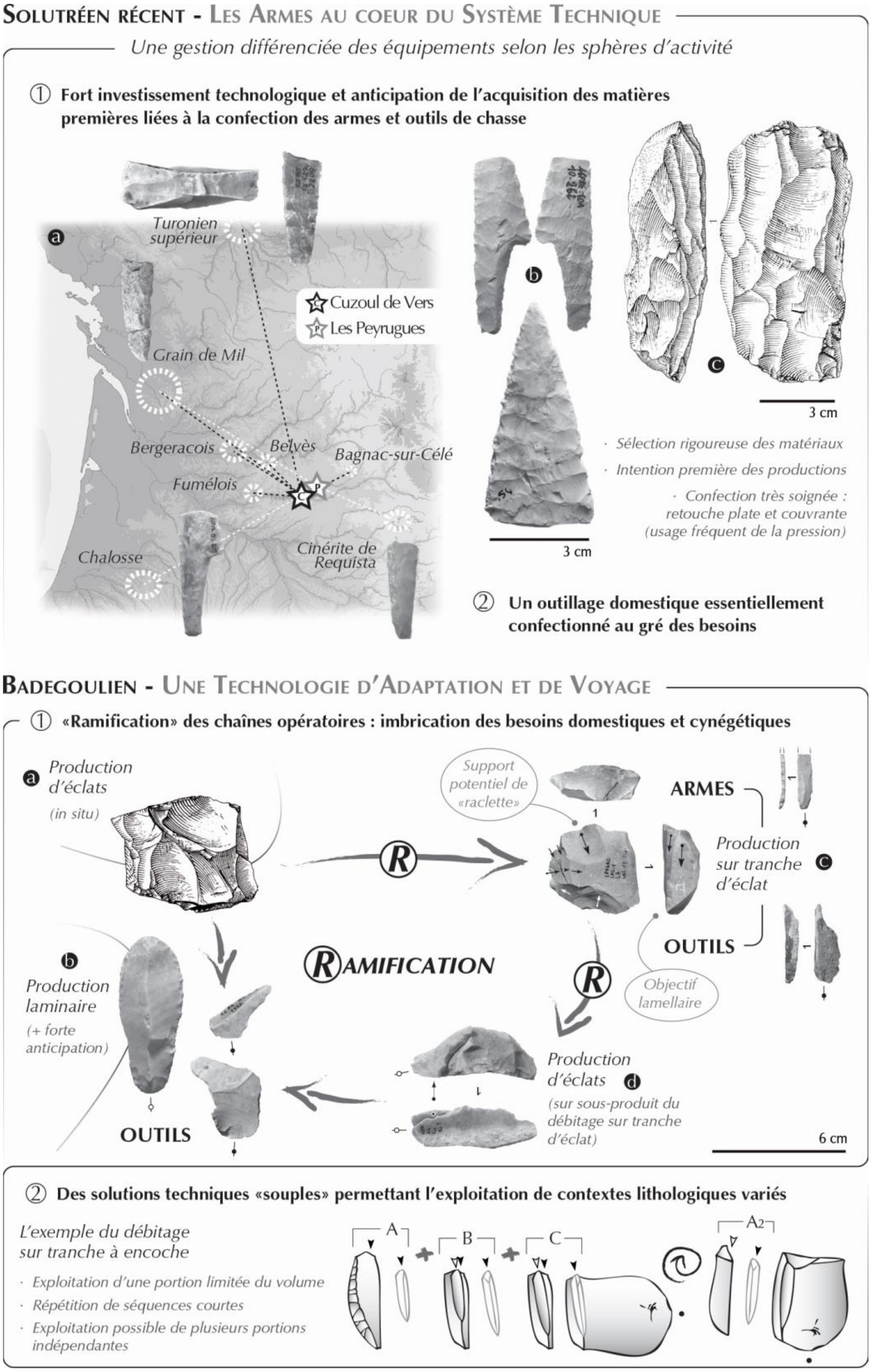


Fig. 35 **Synthetic comparison of the techno-economic structure of the « *Solutréen recent* » and the succeeding Badegoulian in South-Western France (Renard and Ducasse 2015: Fig. 2). Affinity and difference are gauged in terms of systemic 'quality' and technological 'infrastructure.'**

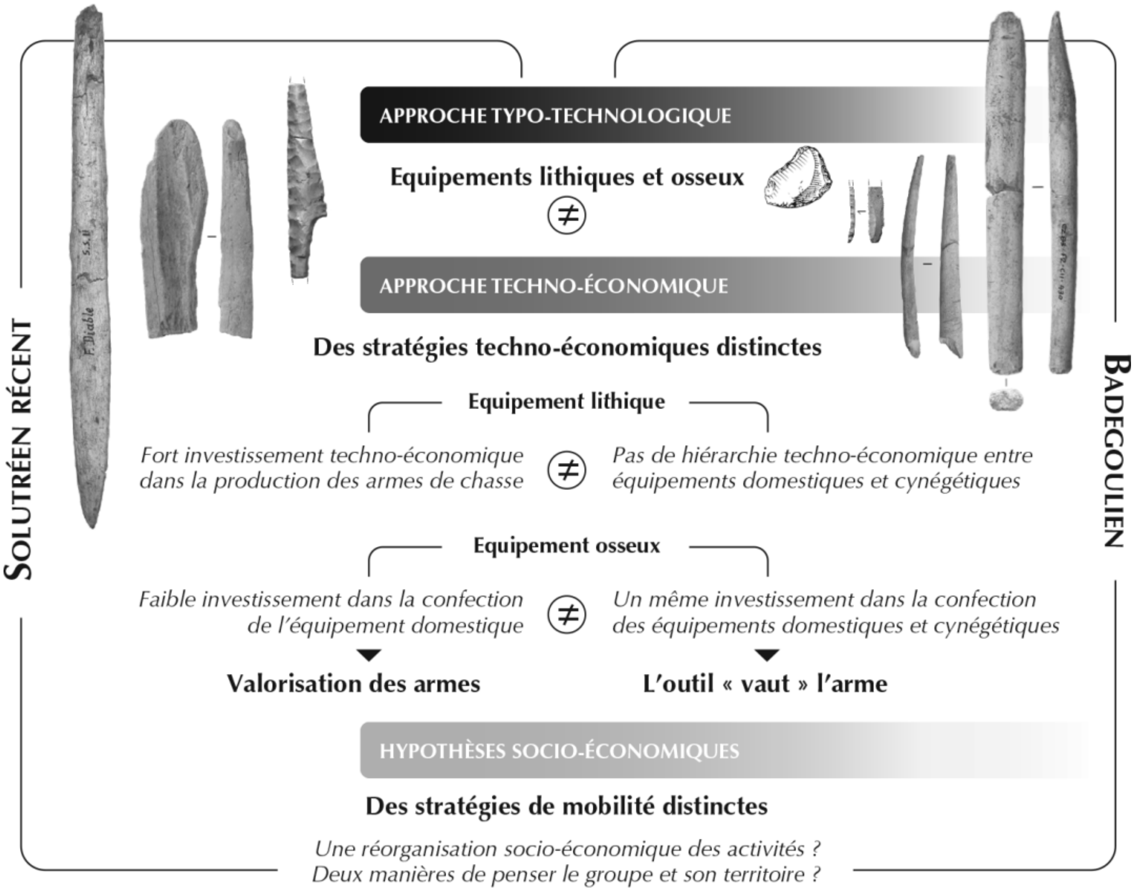


Fig. 36 **Structural comparison of lithic and bone industries of the « *Solutréen recent* » and the Badegoulian in South-Western France (Renard and Ducasse 2015: Fig. 3). Note in particular the sequence of reasoning, drawing implications for economic functioning and the organisation of mobility from the overall structure of lithic and bone technologies.**

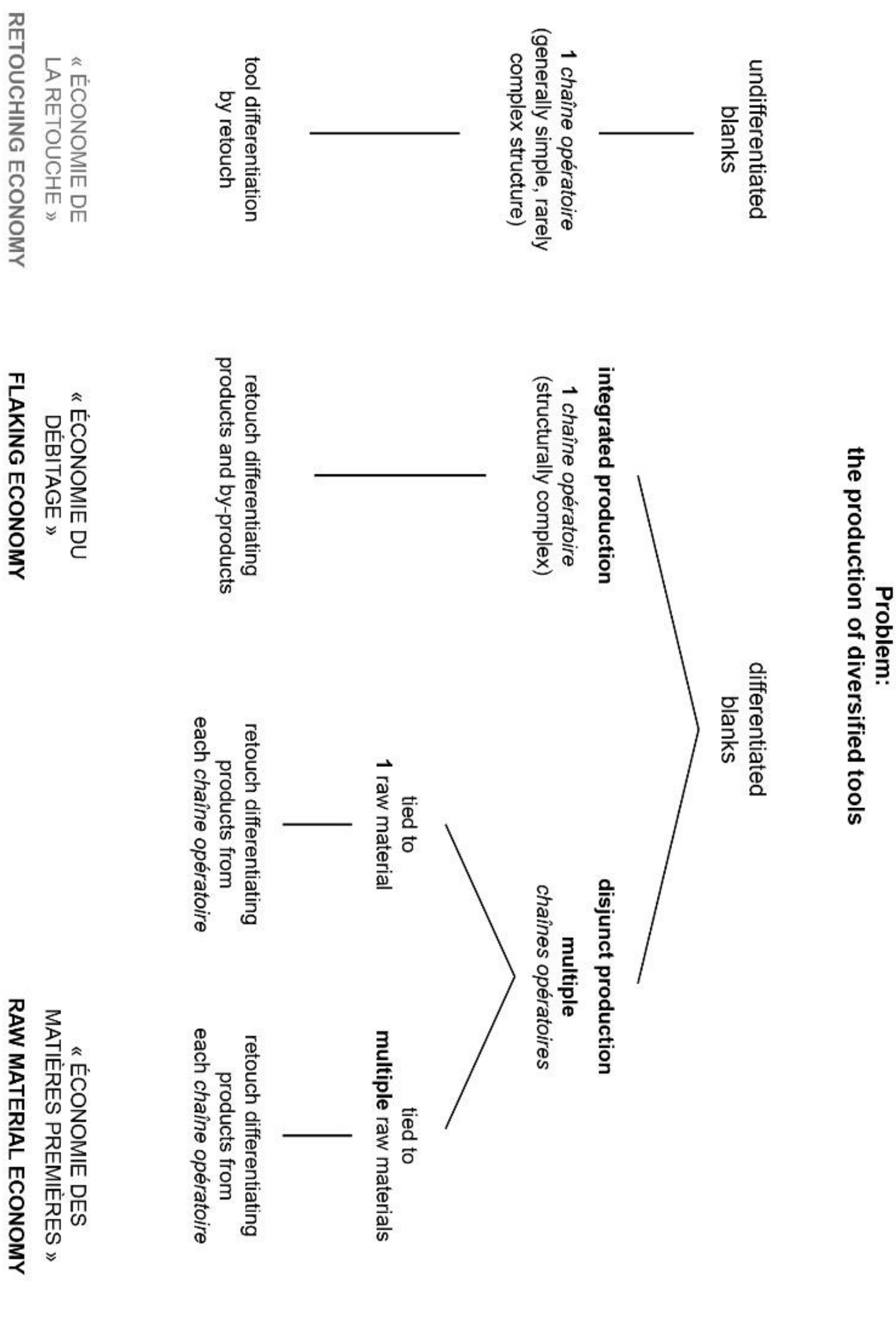


Fig. 37 **Perlès' (1991b) theoretical framework of lithic techno-economic organisation (redrawn and modified). The scheme revolves around two economic solutions to the problem of sustaining diversified toolkits: «** ***économie du débitage*** **» ('knapping economy') and «** ***économie des matières premières*** **» ('raw material economies') [a third but latent solution – «** ***économie de la retouche*** **» ('modification economies') – may be added].**

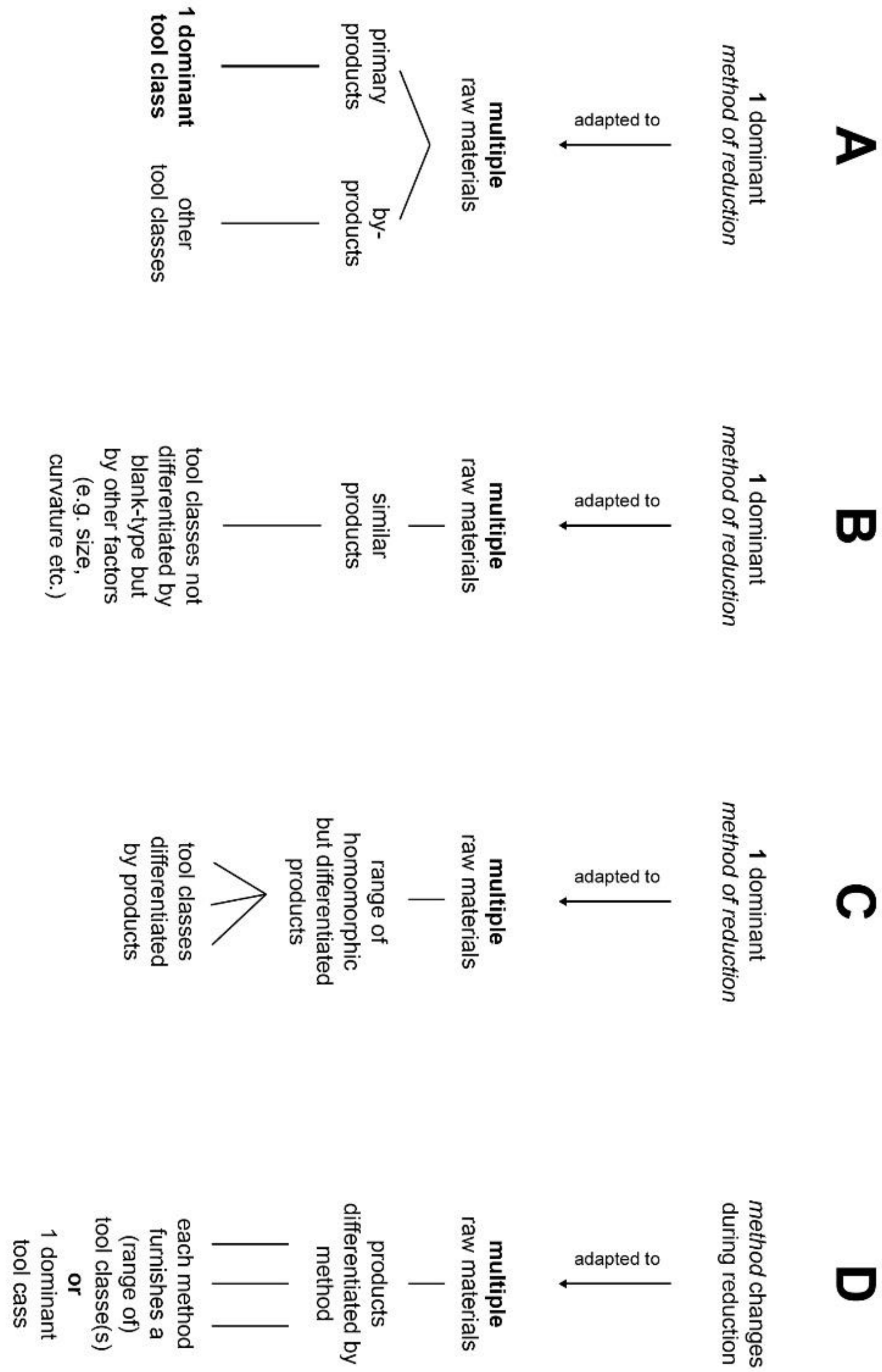


Fig. 38 **Pelegrin's (2011) four-part technological scheme to capture the structural variability of Upper Palaeolithic laminar reduction of Western Europe (figure based on Pelegrin's written account). Note that the main difference between the four suggested technological variants ('A'-'D') lies in the structure of relationships between the constitutive elements of each technical system, including knapping method, blanks, tools, and reduction stage/position.**

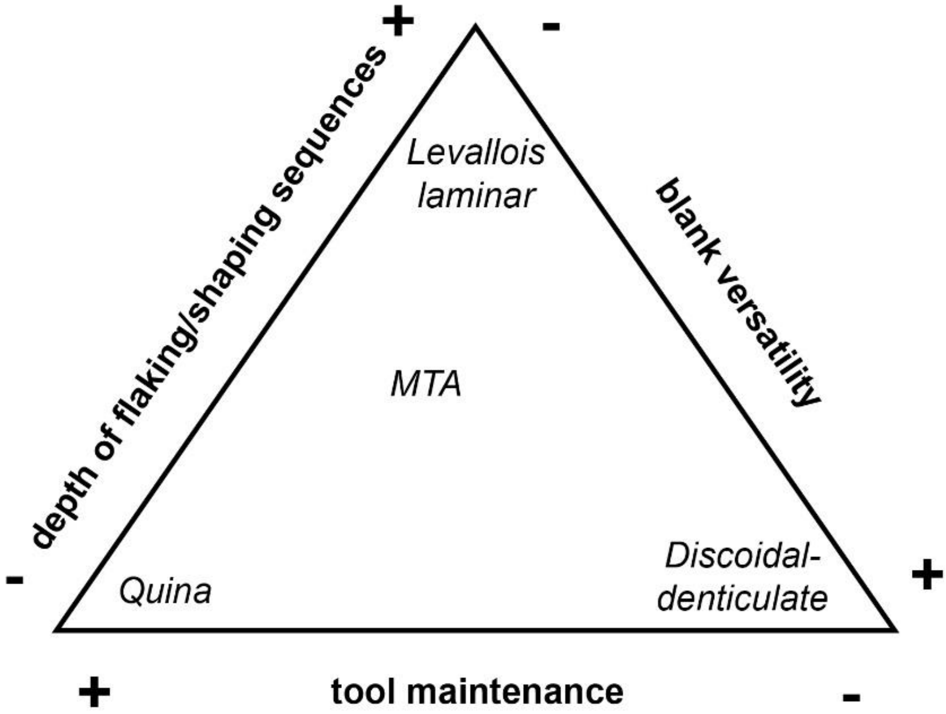


Fig. 39 **Relative position of the four main lithic technologies of Western France in OIS 7 and 3 within the broader economic space of Middle Palaeolithic technicity (redrawn from Delagnes and Rendu 2011: Fig. 5). Note that the relative position of each technical system depends entirely on the position of the other systems. Note also that the three economic poles of the triangle are negotiated on the level of technical systems and are difficult to measure directly in individual artefacts.**

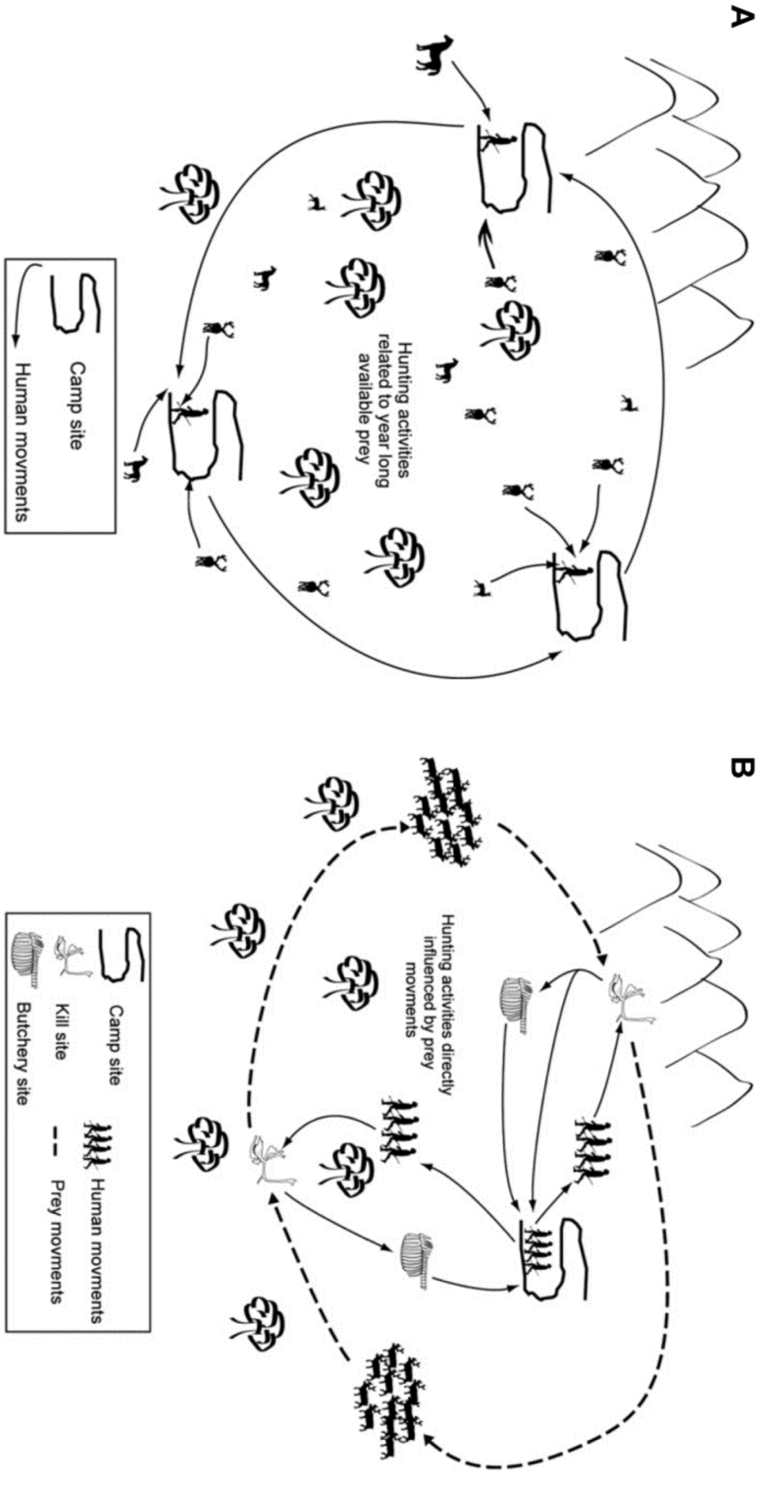


Fig. 40 **Juxtaposition of a 'non-selective' hunting strategy with high frequency moves but medium overall mobility and a 'selective' hunting strategy with satellite sites and seasonal leapfrogging. [A] Reconstructed Levallois-laminar techno-economic system supporting similar site types and a focus on various 'non-gregarious' prey species (Delagnes and Rendu 2011: Fig. 3). [B] Reconstructed Quina techno-economic system encouraging a diversified settlement system and the strategic targeting of solitary or scattered and highly mobile 'gregarious' prey species (*ibid.*: Fig. 4). Note that this reconstruction also insinuates that the varying technologies also support or facilitate distinct hunting tactics.**

		Préparation et/ou entretien du nucléus	Pré-détermination des produits recherchés	Normalisation des produits recherchés	Potentialité de réaffûtage	Ramification	Productivité
Levallois préférentiel		+ + +	+ + +	+ + +	+ +	- - -	- - -
Levallois récurrent	uni/bipolaire	+ +	+ +	+ +	+ - -	+ +	+ +
	centripète	+	+ - -	+ - -	+ - -	+ - -	+ + +
Discoïde		+ - -	+ - -	+	+ - -	+ +	+ + +
Quina		- - -	+	+ - -	+ + +	+ + +	+ + +
Laminaire		+	+	+ +	+ - -	- - -	+ +

Fig. 41 **Synthetic table presenting the principal criteria to evaluate the relative degree of technical elaboration in the Western European Middle Palaeolithic and the general character of lithic techno-economy (Bourguignon et al. 2006: Fig. 1). Crosses indicate the relative strength/elaboration of a technical system in the respective economic domain, while minuses signal relative weakness/delaboration. The number of icons represents the total degree of relative economic d/elaboration. Note that every single qualification depends on the overall context of Middle Palaeolithic technicity (they cannot be established in an 'absolute' fashion) and thus, in principle, rely on any other qualification.**

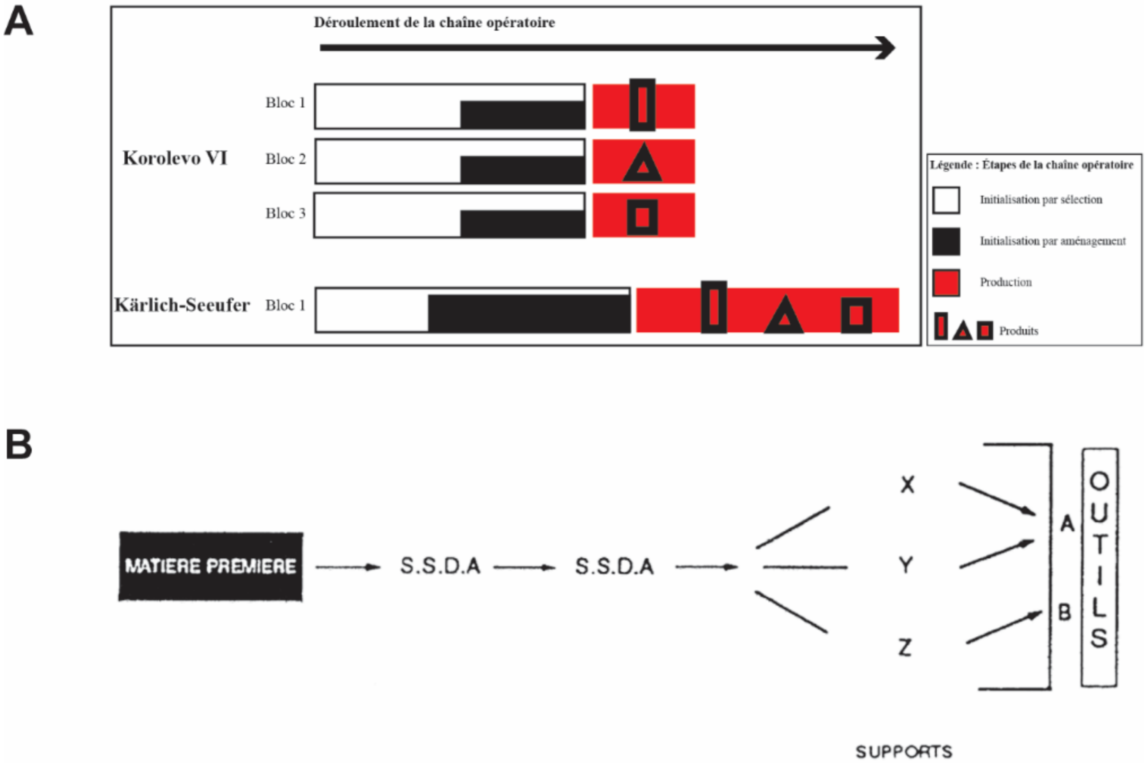


Fig. 42 **Two examples of conceptualising lithic types as "words" in technological "sentences." [A] Inter-relationship between primary blank-types and *chaîne opératoire*(s) in the Lower Palaeolithic of Korolevo VI and Kärlich-Seeufer (Rocca 2013: Figure 163). [B] Relationship between core reduction, blank types, and tool types in the Clactonian (Forestier 1993: Fig. 16.2). Not that the present parts are often the same but they differentially distributed and articulated with one another.**

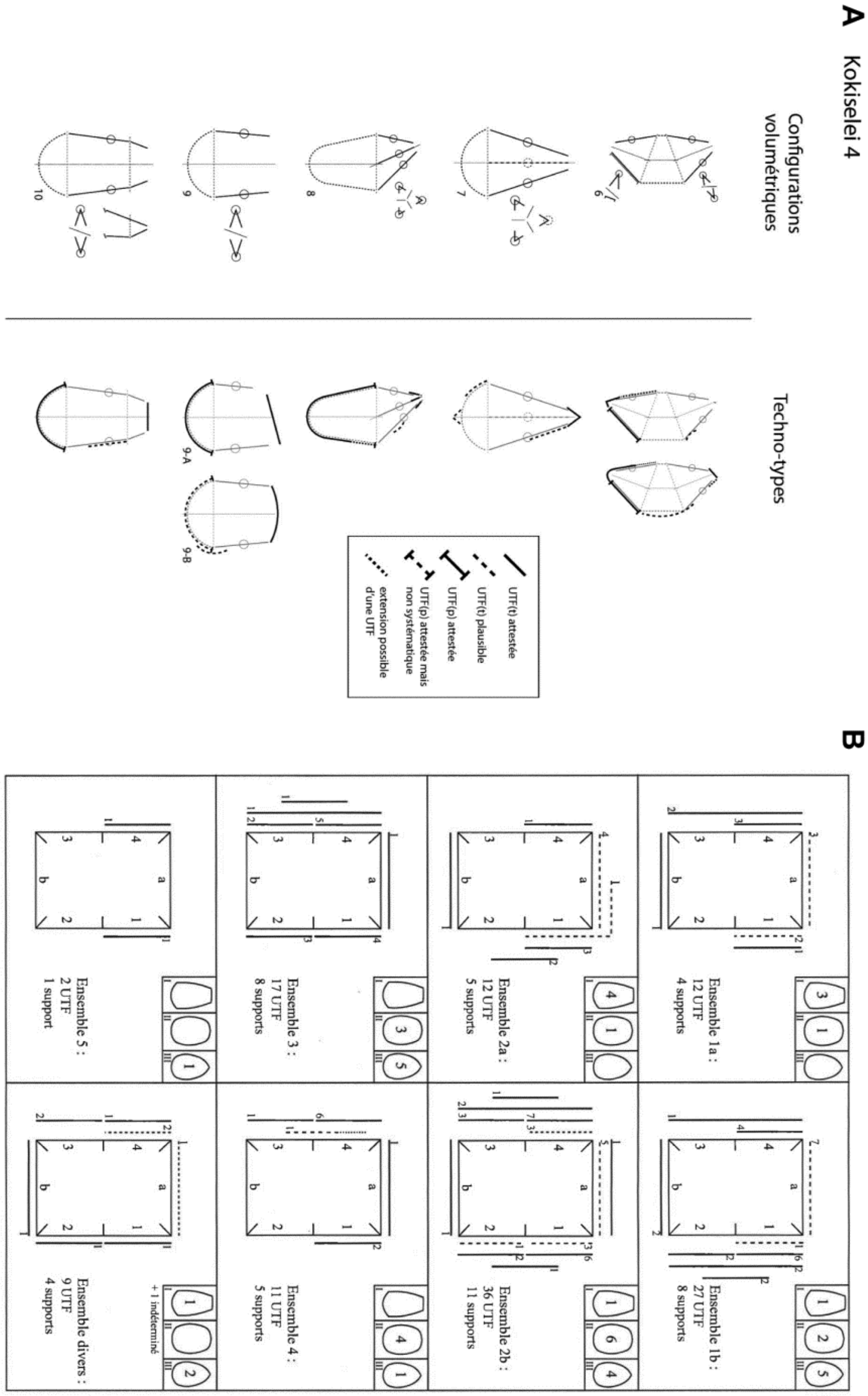


Fig. 43 **Two examples of grouping lithic artefacts into effective 'types.' [A] Relationship between the nature of volumetric configuration (including strategies of volume construction) and 'techno-type' (functional potential of constructed cutting edges) as a possible locus for typologisation (Chevrier 2012: Annexe 4). [B] Classification scheme based on the frequency and geographic distribution of techno-functional units (UTFs) on particular 'morpho-types' (shape-types) in the bifacial technology of Gouzeaucourt G (Soriano 2000: Fig. 119). [For a detailed exploration of the 'UTF' concept, see the next part of the chapter.]**

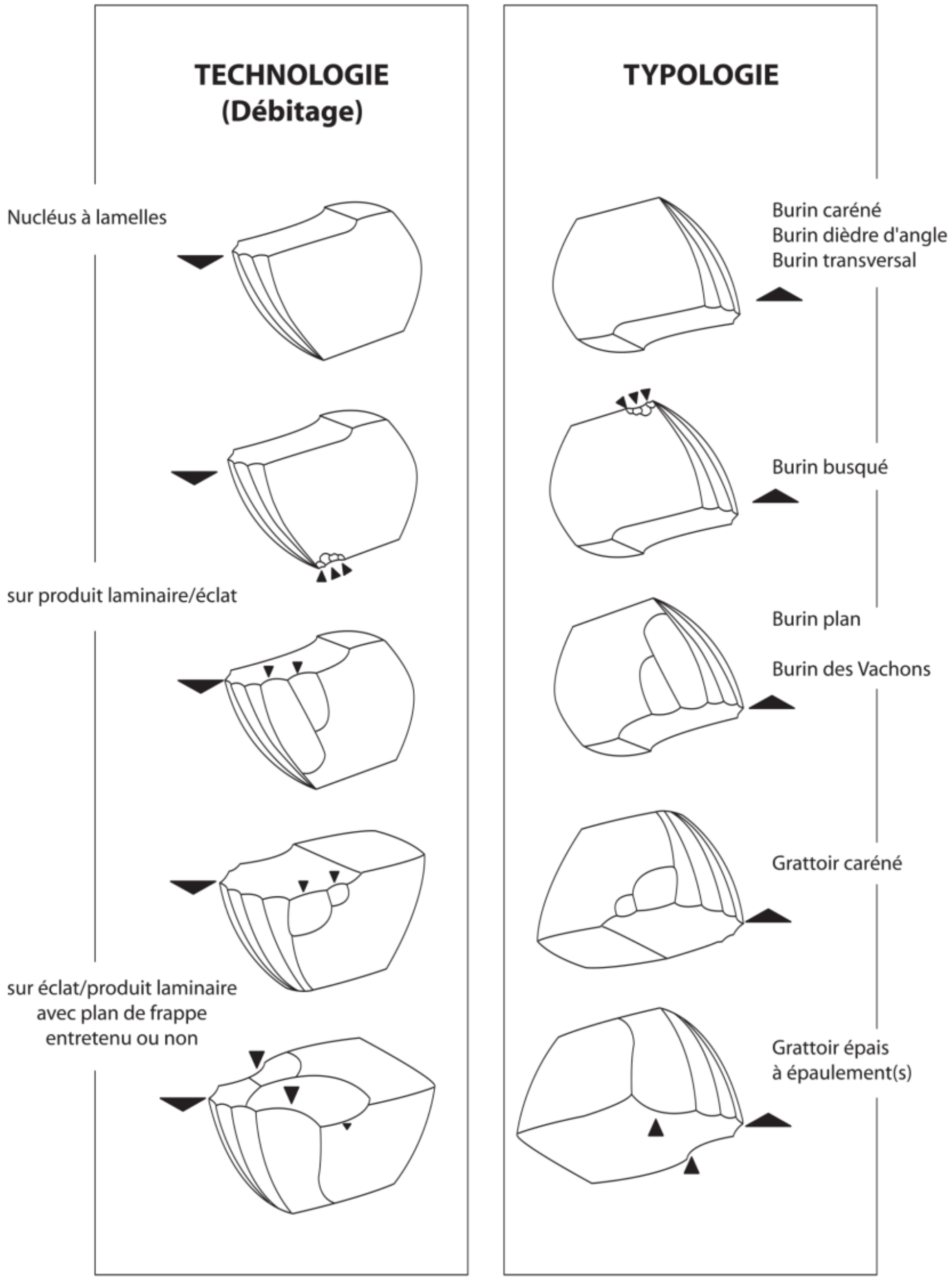


Fig. 44 **Juxtaposition of typological and technological perspectives on burin-like artefacts (Le Brun-Ricalens et al. 2006: Figure 3). Note that not only the description/denomination of pieces changes between the two approaches, but also how pieces are orientated, drawn, and 'read.'**

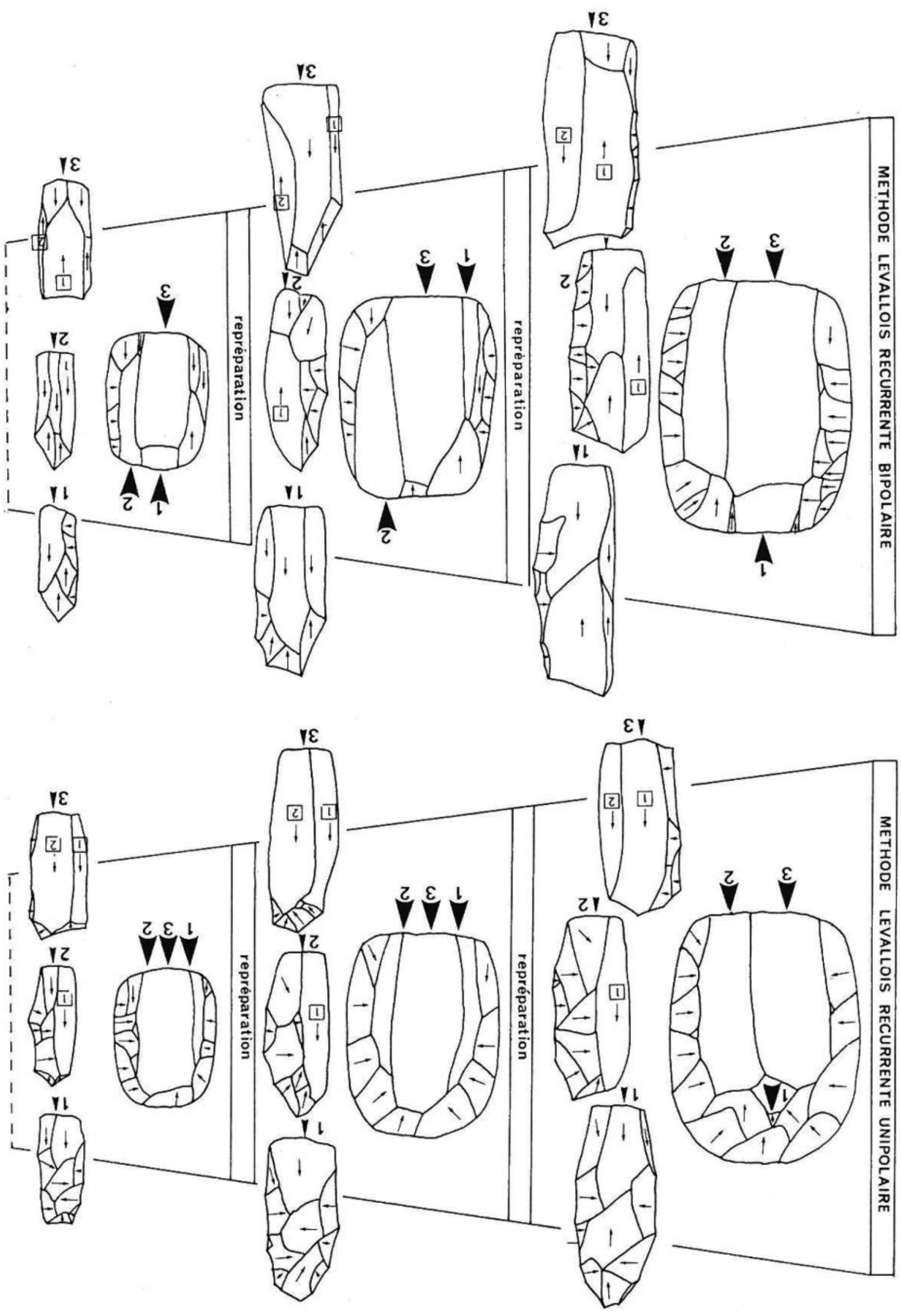


Fig. 45 **Schematic comparison of the two methods of 'recurrent Levallois' identified by Boëda (1986, 1988: Fig. 18.22) in the Biache Saint-Vaast assemblage of level IIA. Note that each reduction stage represents a temporally-defined 'sub-structure' characterised by a distinct sub-set of the blank-core assemblages; each 'sub-structure' hosts a particular spatiotemporal articulation of artefacts. Note also that the scheme theorises the consequences of particular knapping actions for the core volume and the effects of preconfigured core volumes on the character of the resulting blanks. Solving this '4D puzzle' essentially means to resolve the 'fragments of reality' (lithic artefacts) into their spatiotemporal sequences of reduction, the characteristics of which need to be inferred internally.**

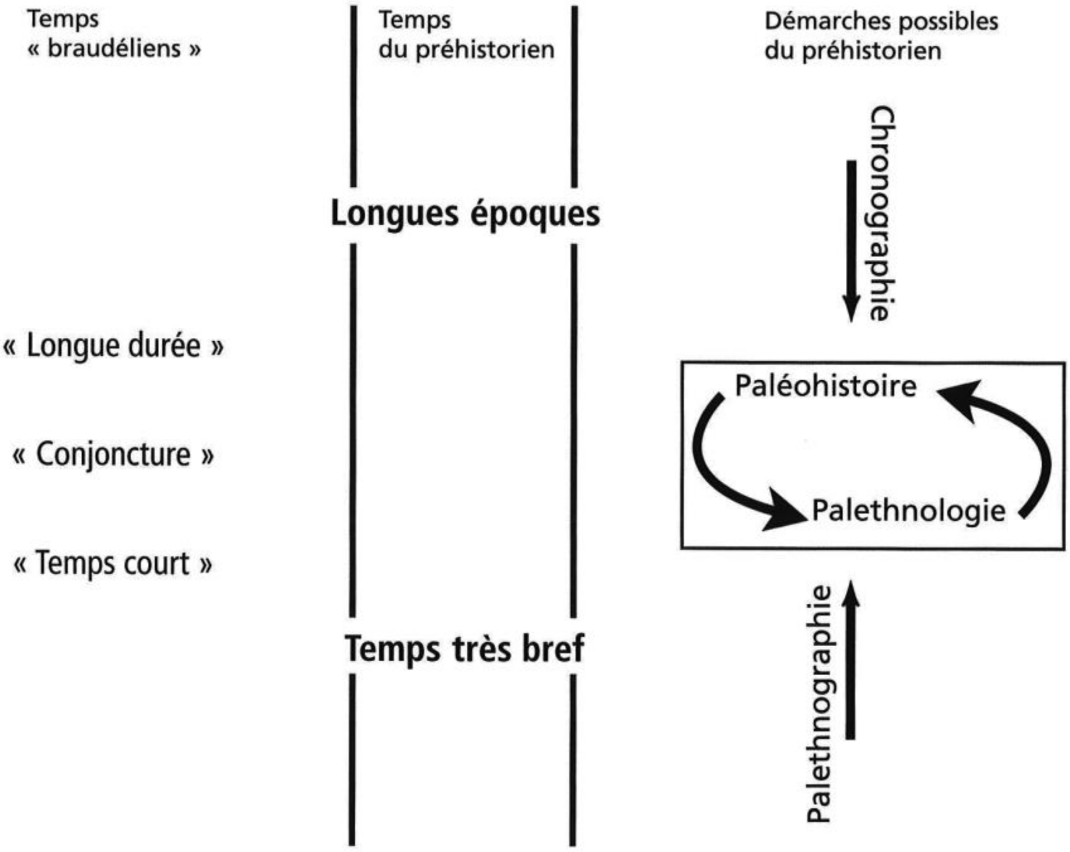


Fig. 46 **Relationship between Braudelian temporalities, 'palaeo-historic' temporalities, and possible prehistoric approaches (Valentin 2008: Fig. 2; see also Audouze and Valentin 2010: Figure 2 for a similar graph). Note that *Chronographie* is not the mere "chronicling" of phenomena but entails, analogously to the practice of *Palethnographie*, and important interpretive element – 'genetic' in the sense that differently scaled phenomena have to be meaningfully connected in time.**

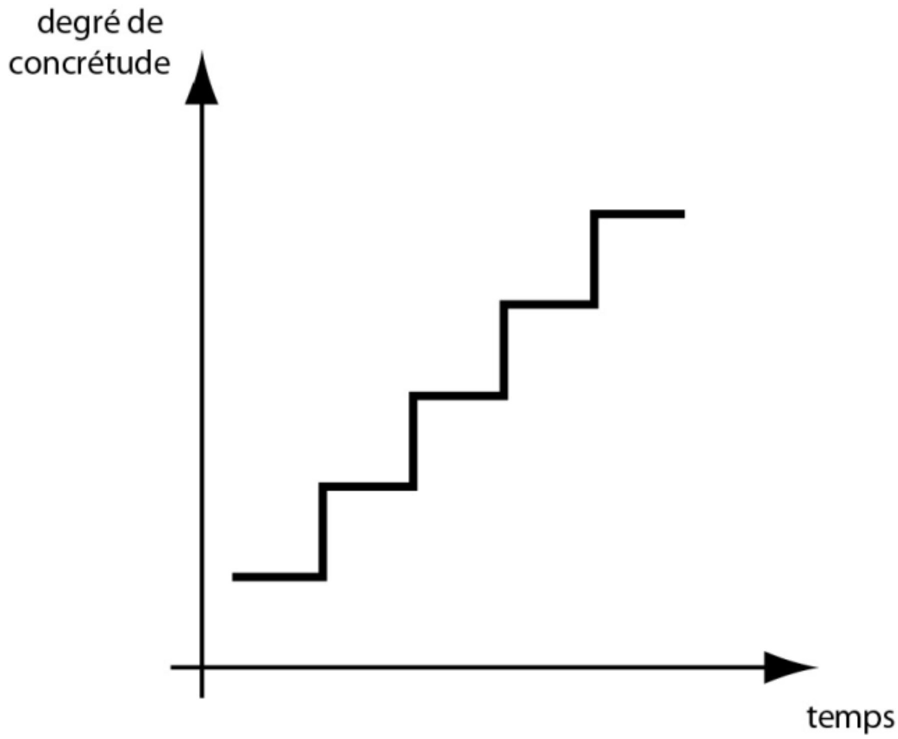


Fig. 47 **Simplified model of 'organic' evolution. Evolutionary becoming is theorised as a non-linear relationship between time and degree of technical 'concrete-ness' (Chevrier 2012: Figure 33). Note the stair-like character of technological evolution implied by this view: technical systems tend to stabilise themselves on various levels of functional coherency (states of 'internal functional equilibrium') while simultaneously thriving towards a more effective integration of their functional parts. Depending on the specific technology in question, 'abstract' system-states are expected to occupy the lower stairs of the evolutionary ladder whereas more 'concrete' states seize the uppermost stairs. This model ultimately hypothesises 'continuity in discontinuity' and therefore pictures technical evolution as neither fully gradual nor fully saltatory, but as assuming an *eigen*-rhythmical combination of both of them.**

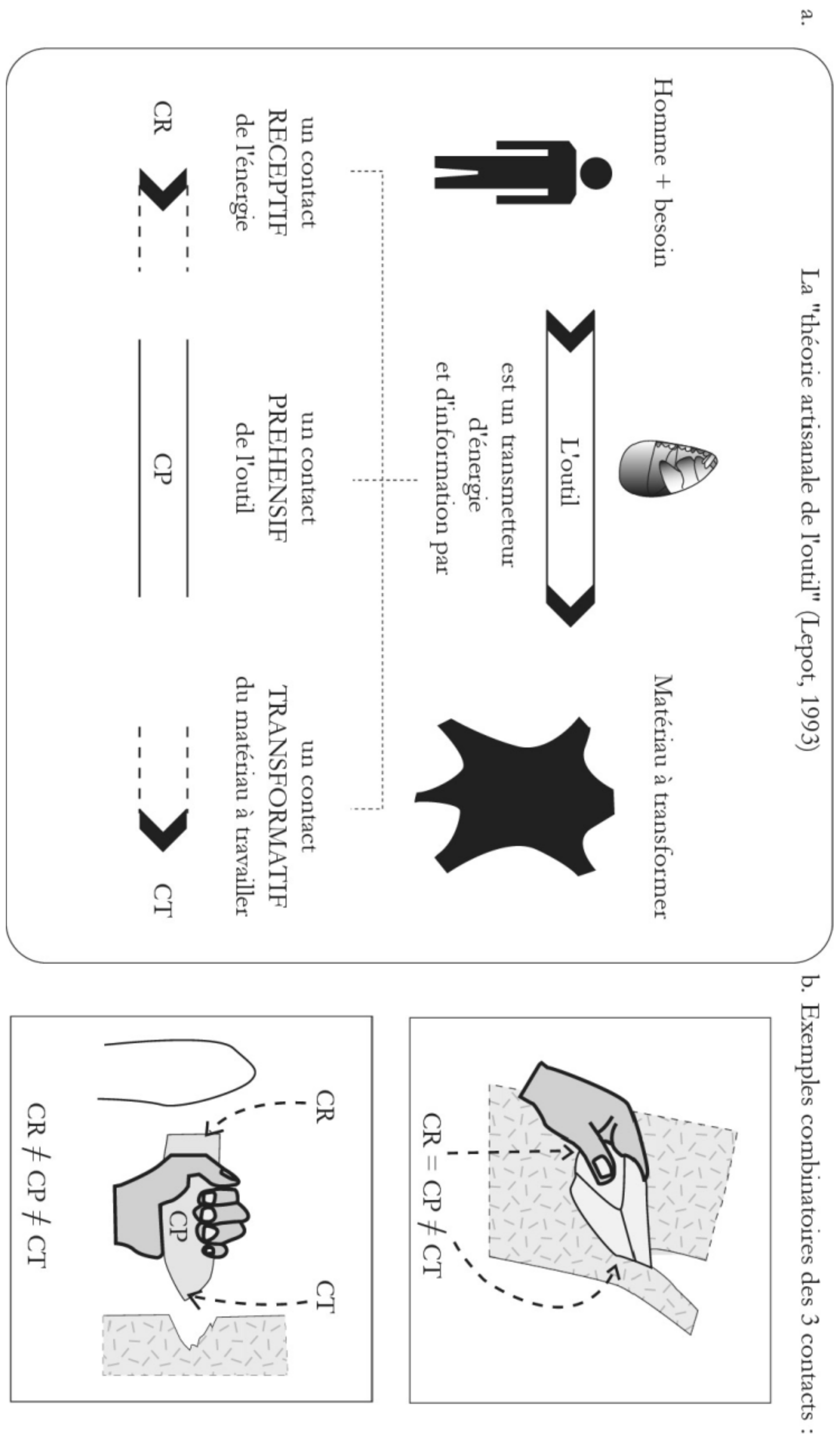


Fig. 48 **Schematic overview of Lepot's « *théorie artisanale de l'outil* » (Nicoud 2011: fig. 9 after Lepot 1992/1993: Planche 14). This theory considers the design of a tool (tool structure) as key for its functional potential. Each tool potentially consists of up to three distinct techno-functional units ('CR,' 'CP,' or 'CT') that can be combined in a number of different ways to satisfy different functional needs. Note that the theory not only takes into account the techno-functional design of cutting-edges, but also recognises that varying modes of grip and the differential potential to haft tool structures are central building blocks of understanding a "tool in action."**

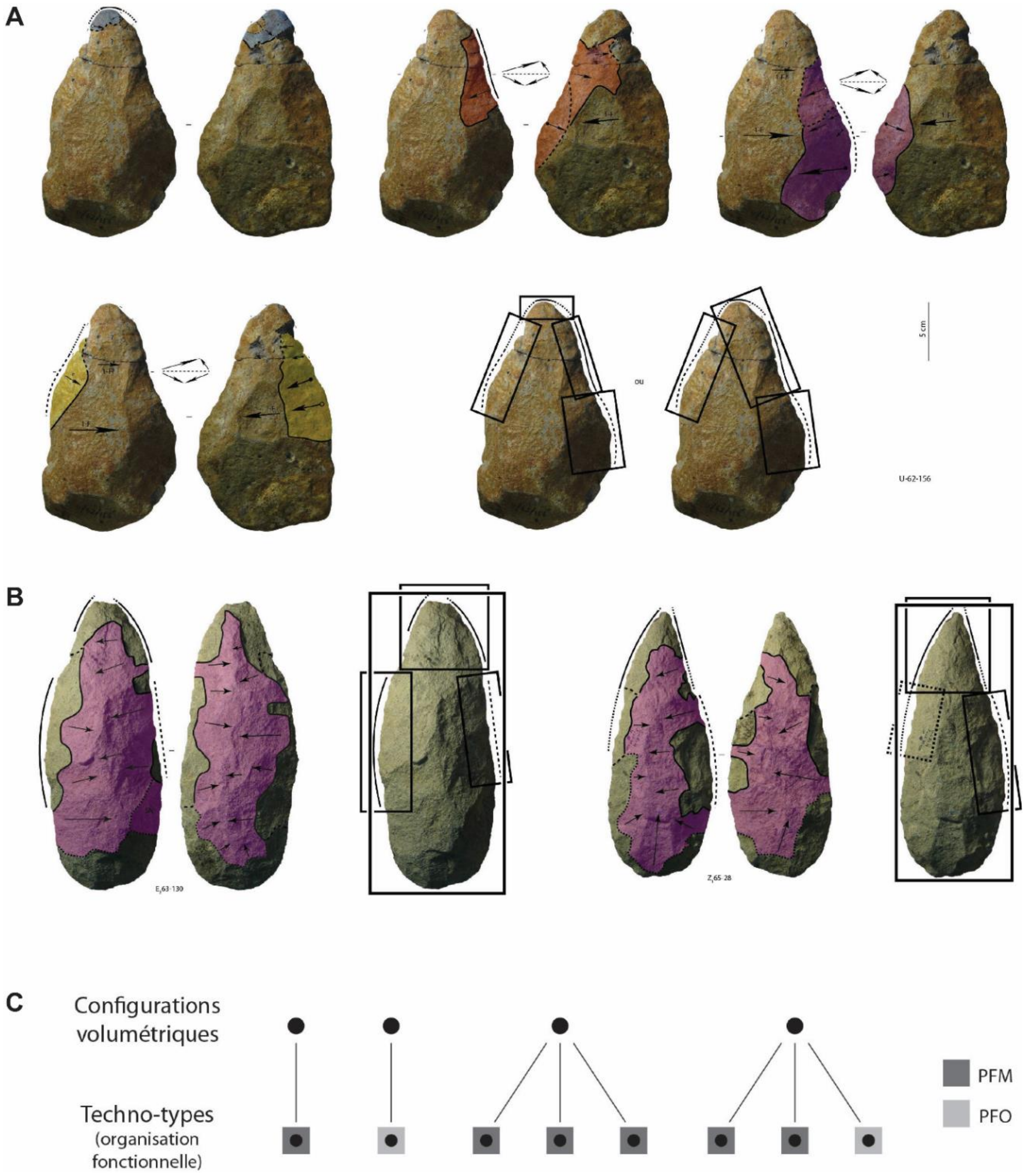


Fig. 49 **Examples of reconstructed tool-blank and inter-tool/inter-UTF relationships in bifacial technology. [A] Ubeidiya K-30, *caractère additionnel* of UTF-artefact relations (UTFs are distinct and do not synergise with the general volumetric design of the respective bifacial pieces) (Chevrier 2012: Figure 347); [B] Isenya VIa, *caractère intégré* of UTF-artefact relations (UTFs are distinct but well-integrated into the overall structure of the respective bifacial pieces) (*ibid.*: Figure 236); [C] logic of inferring structural families of 'techno-types' (specific volume conceptions may support or not a unique UTF-type or multiple UTF-types (ordered hierarchically or not) (*ibid.*: Figure 55). Note that [A] and [B] exhibit 'pluri-tools,' that is, bifacial artefacts that bear multiple but distinct UTFs at the same time. The resulting distinction between 'mono-' and 'pluri-tools' introduces yet another layer of techno-functional variability, possibly discriminating between different 'families' of technical objects.**

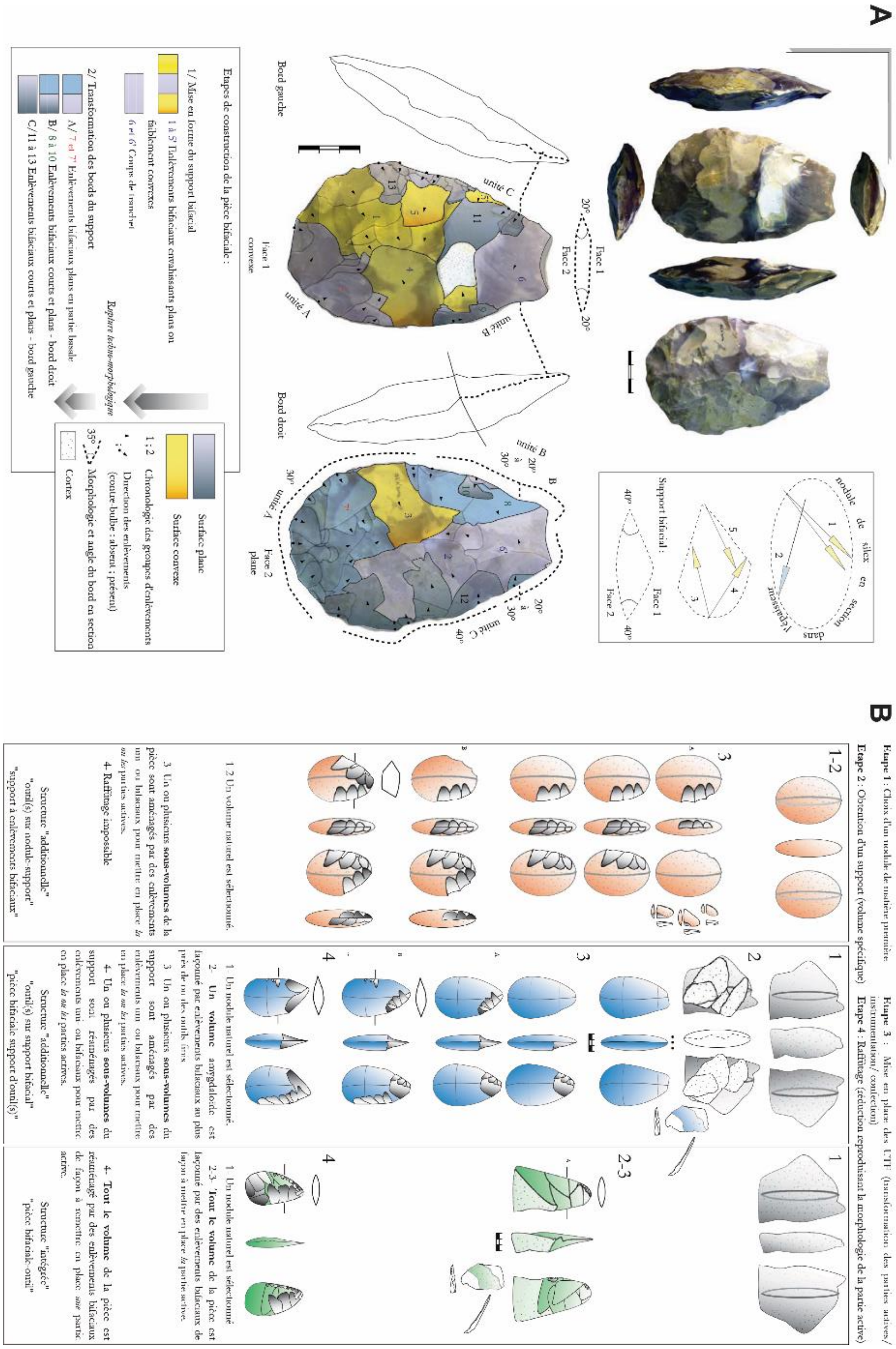


Fig. 50 **Proposed linkage between tool structure and the ‘integrated’ or ‘disintegrated’ construction of bifacial volumes and working edges. [A] Diacritical and techno-functional analysis of bifacial piece n°2 (3096) from Boxgrove Q1/A/4b (Nicoud 2011: fig. 44). [B] Proposal of three distinct schemes of bifacial technological structure: (left) *galets à enlèvements bifaciaux* (‘false biface’ or bifacially exploited core); (centre) *pièces bifaciales supports d’outil*(s) (bifacial volume is constructed prior and serves as tool-blank); (right) *pièces bifaciales-outil* (volume- and tool-construction are intertwined, ‘true’ biface-tool) (*ibid*.: fig. 126).**

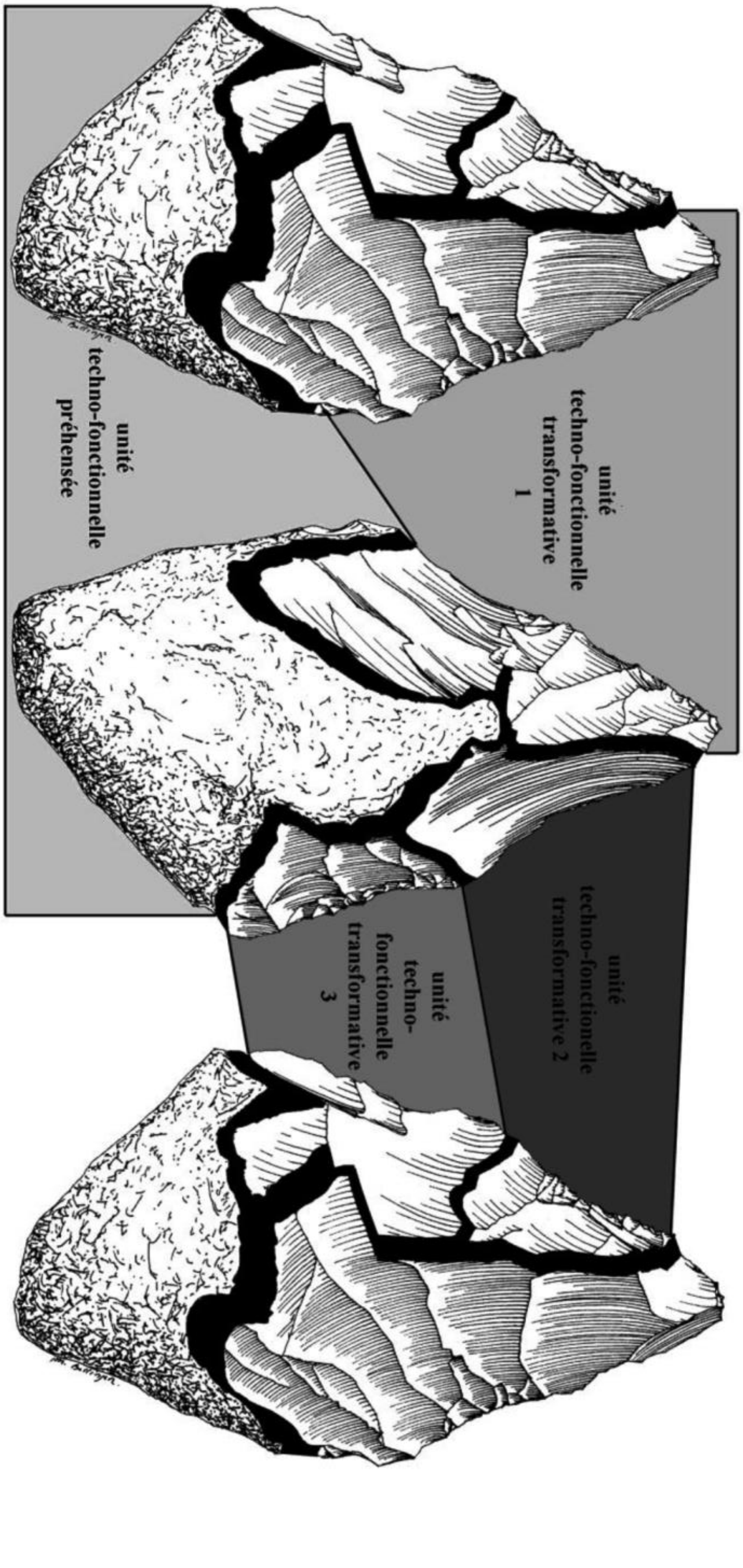


Fig. 51 **Example of multiple UTFs on a single bifacial tool from El Meirah, Syria (Boëda 2013: Figure 20).**

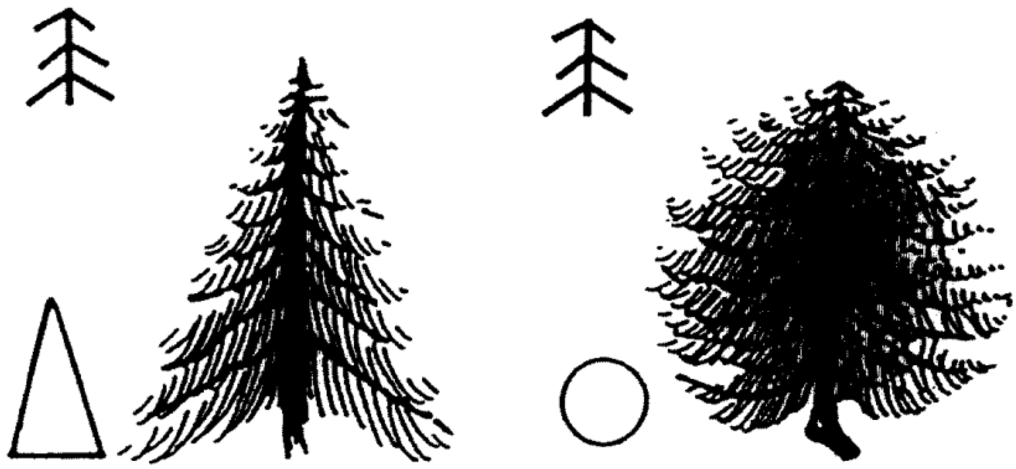


Fig. 52 **Problematic relationship between form and structure. The example of different trees built according to the same structural plan illustrates that form-structure relationships are an important locus of variability (Forestier 2000: Figure 10). The general message is that the 'phenotypical' appearance of lithic technology is more often than not misleading and scholars should hence invest at least equally into the mapping of technological 'structure-types' (these may be referred to as technical 'genotypes'). Note that this line of reasoning is typically to a poignant critique of 'form' and the desideratum to retrieve the 'deep structure' of a technical object; it reveals the 'organicistic' concern with the gap between 'appearance' and 'reality.'**

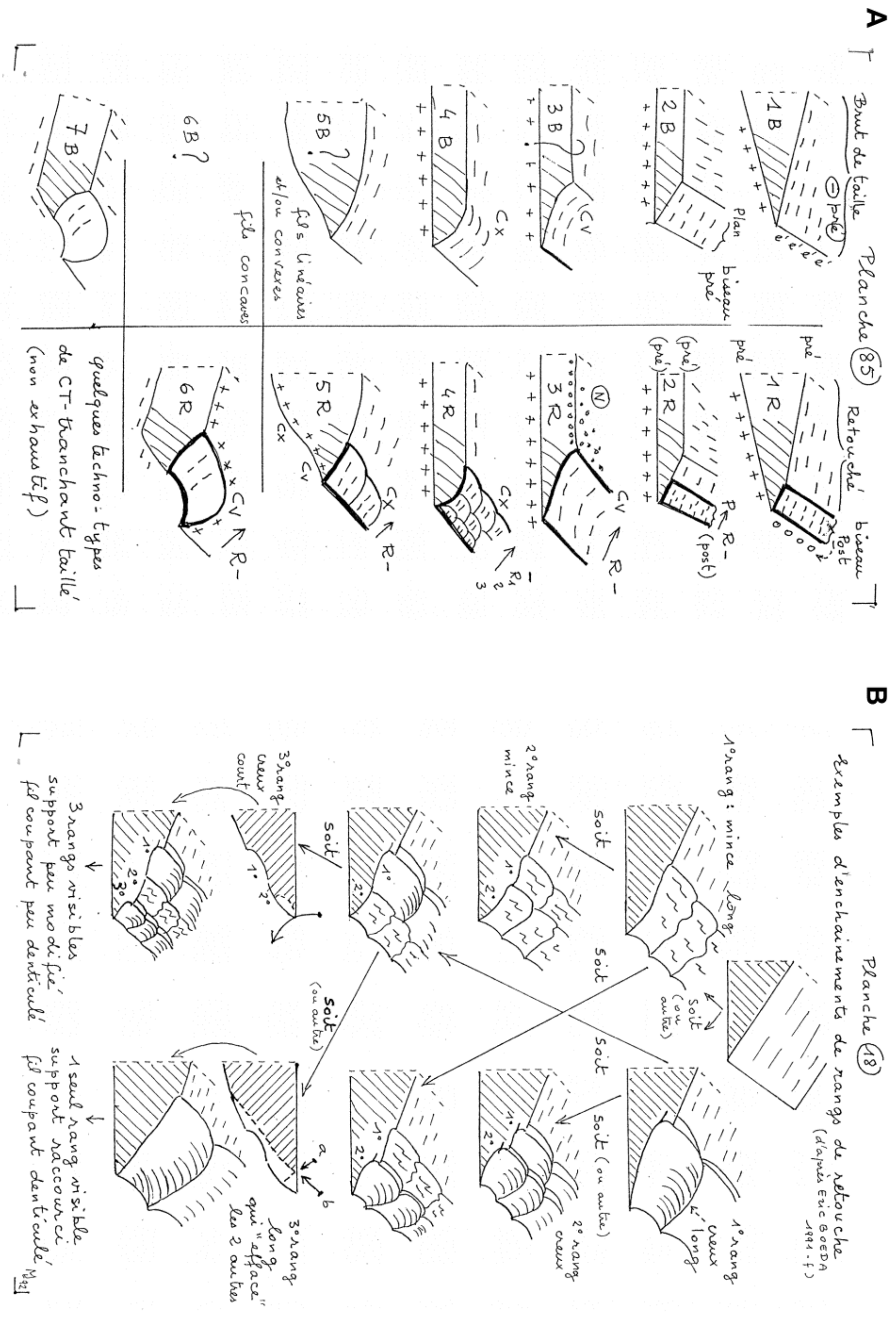


Fig. 53 **Techno-functional architecture of a tool's cutting edge. [A] Various examples of possible 'techno-types' based on cutting-edge cross-section, overall cutting-edge morphology, structure of cutting-edge removals (if any), symmetry/dissymmetry of present cutting-edges, and the relationship of cutting-edges and other functional and non-functional tool surfaces (Lepot 1992/1993: Planche 85). [B] Example of the gradual but directed transformation of cutting-edge morphologies through successive modification and re-sharpening (via different 'gestures of retouch') (*ibid.*: Planche 18). Note that the same methodological principles that guide the determination of core concepts are used to understand the techno-functionality of cutting edge configurations – it is in this sense that we may speak of a 'micro-technological' approach, a 'micro-*lecture*.'**

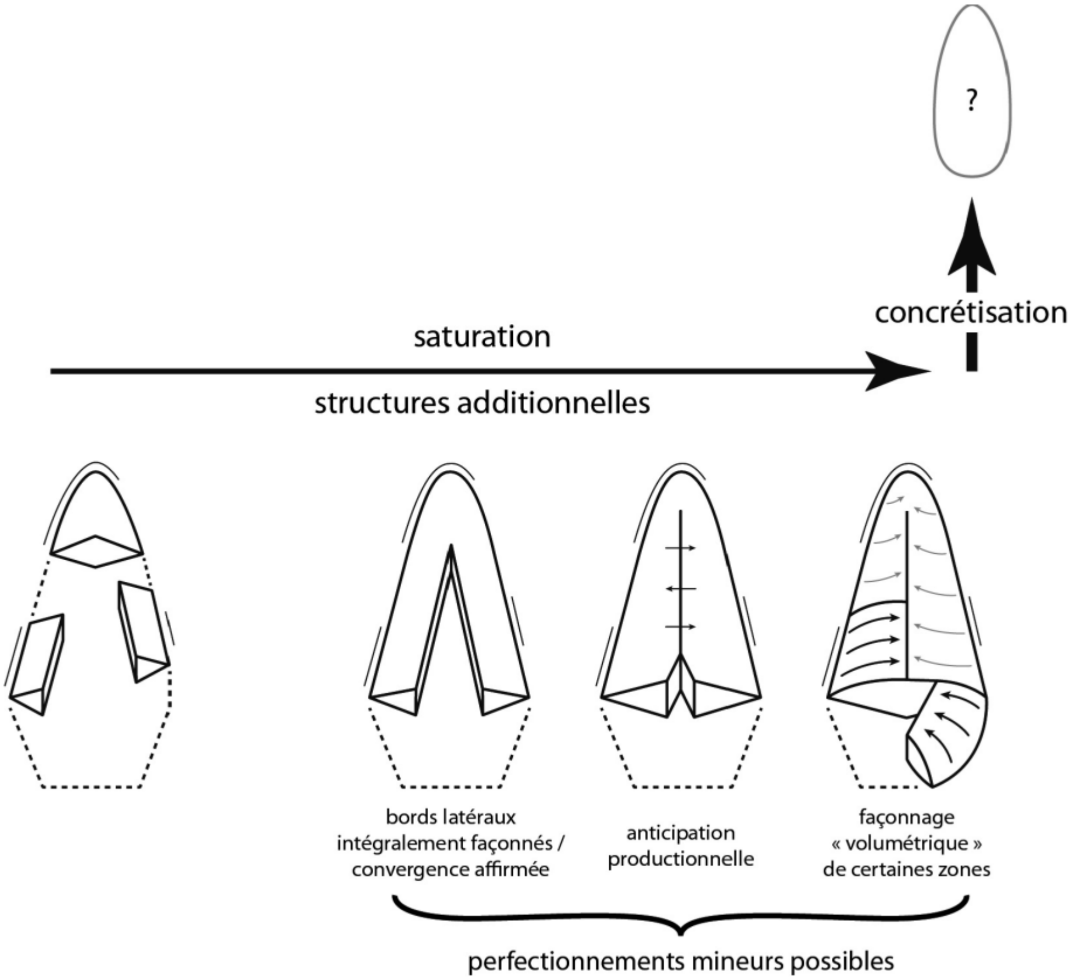


Fig. 54 **Possible scenario of the functional integration of varying UTF elements on a single lithic tool over evolutionary time (Chevrier 2012: Figure 470). The diagram illustrates the process of functional 'saturation,' that is, how the functional potential of a technical object is step-wise realised over time. Note that the associated process of 'concretisation' can be achieved through a number of different technical operations. This implies that although the principle of integration is thought to be a universal, the precise trajectory of functional integration is never fully predictable and can only be 'diagnosed'** ***after*** **a technical lineage has been reconstructed in its totality.**

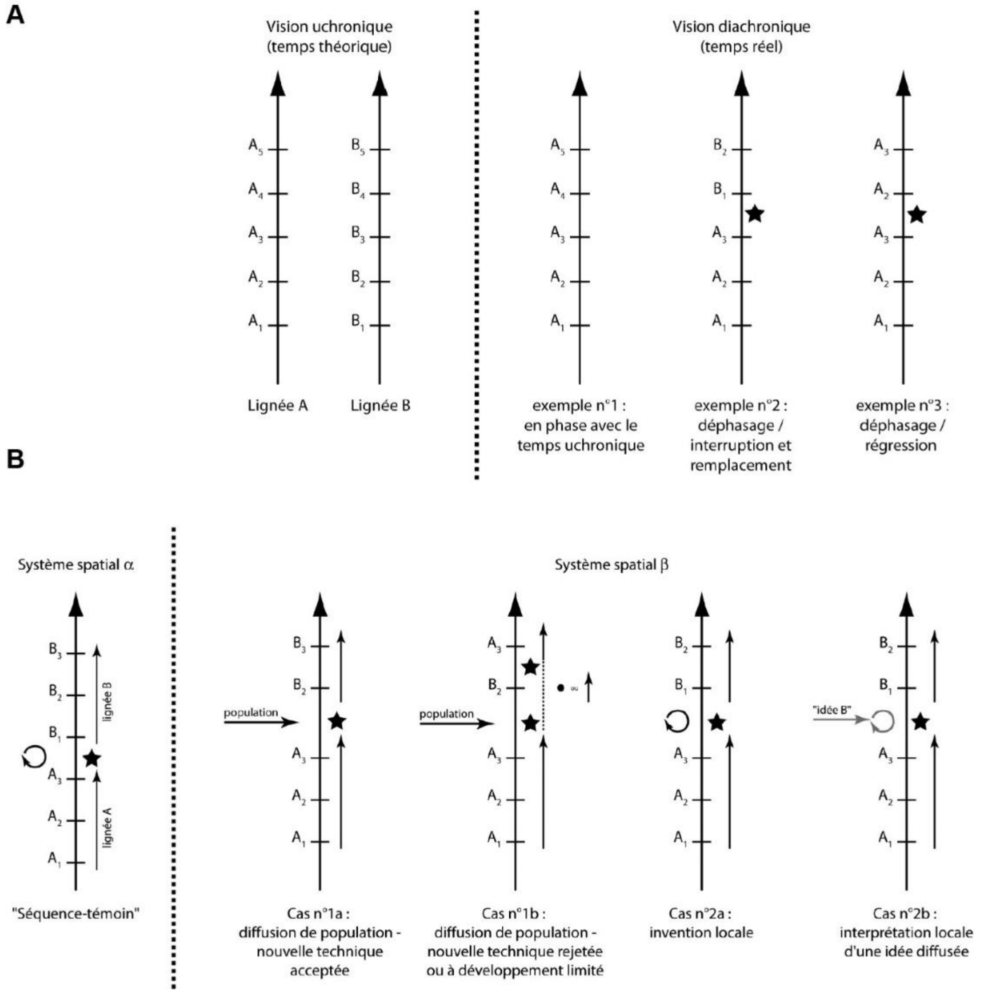


Fig. 55 **Theoretical relationship between unfolding 'technical lineages,' interfering 'abnormal' events, and external shocks. [A] Comparison of theoretically expected ('ideal') progressions of technical evolution (left) and actually observed evolutionary sequences (right) (Chevrier 2012: Figure 34). In the 'ideal' scenario, each lineage's 'technical essence' (A or B) passes through a number of successive stages (A1-A5, B1-B5) until relatively 'concrete' stages are reached. In real diachronic time, however, unexpected events (stars) might interrupt and/or reset a lineage's technical progression. Note that these external impacts are detected by studying the logic of internal unfolding, not by the study of the external factors themselves. [B] The identification of lineages and their progression is naturally bound by spatial factors and enables the comparison of evolutionary dynamics in different spatial systems (*ibid.*: Figure 37). Note that a 'spatial system' is not *a priorily* given, but can only be 'diagnosed.' Two or more spatial systems can be compared in order to establish the likelihood of different theoretical situations that may explain what is observed. Abnormal events may be the result of population diffusion (black horizontal arrows), local inventions (black circular arrows), or the local re-interpretation of travelling ideas (grey horizontal arrow with grey circular arrow). Note that this logic of comparison is not correlative, but seeks to detect offsets that explain the abnormalities in a spatial system, e.g. by invoking the character of technical evolution in another, ideally adjacent system. The general logic underscores that 'conflict,' interpreted through the lens of the 'progressive' and 'ideal' categories of a given technical lineage, is a key interpretive category of 'techno-genetic' reasoning.**

Tables

Site	Level(s)	Type	Geographic location	Chroncultural position	Focus of analysis	Primary sources*	Supplementary sources
Biache Saint-Vaast	IIA	open air	Northern France	MIS 7/Early Middle Palaeolithic	Levallois technology	Boëda 1988; Dibble 1995a	Boëda 1986, 1994; Hérisson 2012
Gouzeaucourt	G	open air	Northern France	MIS 7-8/Lower-to-Middle Palaeolithic transition	Bifacial technology	McPherron 1994; Soriano 2000	McPherron 1999; Iovita and McPherron 2011
Kulna	9a, 7**, 7c, 7a, 6b	cavity	Czech Republic	MIS 3-4/Late Middle Palaeolithic (Micoquian)	Discoid technology	Boëda 1995a, 1995b; Tostevin 2012	Boëda 1991, 1993; Tostevin 2000

Tab. 1 **General specifications of the three comparative assemblage-based case studies. [* = Primary sources specify the literature on which the conceptual analysis was based on. ** = While Boëda has studied all of the listed Micoquian layers from Kulna cave and interpreted them in their totality, Tostevin's examination includes only level 7.]**

Case study	**Main results of French analysis**	**Main results of Anglophone analysis**
	Boëda 1988	*Dibble 1995*
Biache Saint Vaast IIA	multiple independent *chaînes opératoires*; 5 flaking schemes (A-E) and 2 dominant Levallois methods (uni- and bidirectional Levallois recurrent); the two 'Levallois recurrent' methods are characterised by three distinct but differential stages of *débitage*; different methods are corroborated by the overall metric stability of the cores and the predetermined blanks they host; continuous distribution of blank dimension throughout the three reduction stages of Levallois recurrent systems bespeaks of a recurrent mode of production (*débordant* flakes are also present at each stage); lithic technology is well structured and blank-tool relationships well-defined (different stages of reduction and different blank-types provide the raw material for different tool-types); blank-use is foreshadowed by blank-production and not only a function of modification; well-organised technological knowledge (*savoir faire*) is indicative of a particular technical tradition	assemblage-type 'Moustérien à Ferrassie'; continuous reduction of cores with changing reduction patterns (blank-size differences correlate with differences in blank scar patterns, revealing a trajectory from uni- and bidirectional reduction to sub-radial reduction); general correlation between artefact size and reduction depth (larger blanks tend to bear more cortex than smaller blanks, cortex ratio is positively correlated with platform facettation, length-width ratios change in relation to blank size-class); uni- and bidirectional Levallois products do not differ in any single measure; there is no empirical support for two independent knapping patterns (a simpler explanation is that they change with reduction depth); blank-tool relations are weekly defined and selection is mainly a matter of modification (main selection factor is blank size, technological classes are not systematically tied to specific tool types); shape (measured by the laminarity of blanks) also fails to be an effective selection factor
	Soriano 2000	*McPherron 1994*
Gouzeaucourt G	bifacial technology (*façonnage*) co-occurs with a weakly determined core-blank technology (*débitage*); construction of bifacial volumes is realised through biconvex shaping (absence of facial hierarchies in bifacial blanks); construction of bifacial blanks is well separated from the installation of functional edges on these blanks; most bifaces are highly reduced and considerably re-sharpened but much of this happened before they were introduced to the site; conceptual and technical complementarity between *débitage* and *façonnage*; (*débitage* = low degree of conceptual elaboration, low *savoir-faire* required, short reduction sequences, small to medium sized products of decent morpho-technical regularity, highly diverse functional potential	assemblage is dominated by ovates and thin bifacial forms; strong relationship between edge shape and tip length (bifaces with long tips are more likely to be pointed than bifaces with shorter tips); ongoing reduction results in more rounded forms as tip lengths decrease; ongoing reduction results in reduced elongation values; bifaces are highly reduced and the data confirms that reduction depth is the main driver of bifacial variability (general trajectory: from pointed to round forms); patterns of variability have most likely nothing to do with broad regional or temporal factors but are rather caused by localised circumstances; variability pattern probably a consequence of long occupation history; no evidence for cognition as a significant mechanism

	of blanks, almost completely produced on-spot/low mobility); *façonnage* = *schéma opératoire* to a lesser degree constrained by structural imperatives, central objective is the construction of a regularly shaped and globally oval bifacial blank, good amount of *savoir faire* required, high import component/high mobility; synergetic implementation of UTFs; eight distinct techno-functional groupings of bifaces; high conceptual diversity within the *façonnage* category; spatio-temporal differentiation between volume construction and re-sharpening within the same *culture technique;* *débitage* and *façonnage* systems supplement each other on the functional plan and represent differential working options geared towards different activities	
	Boëda 1995a	*Tostevin 2012*
Kulna 9a, 7*, 7c, 7a, 6b	presence of two distinct *chaînes opératoires* (*chaîne opératoire de façonnage* plus *chaîne opératoire de débitage*); *façonnage*-production is centred on plano-convex bifacial pieces with characteristic cutting-edge morphology; bifacial pieces are constructed by two different methods; plano-convex pieces serve as bifacial blanks and are secondarily retouched to create various Middle Palaeolithic tool types; plano-convexity creates bifacial blanks with similar retouch potential as ordinary *débitage* blanks; clear-cut distinction between blank- and tool-construction in bifacial technology (over-determination of bifacial blanks); *débitage*-production is centred on a Discoid system defined by the interaction of six technical criteria; Discoid production is characterised by a particular volumetric architecture, well-defined technical rules and a set of four typical Discoid blanks (considered predetermined); Discoid production is a stable and self-stabilising reduction structure with a high degree of morphological recursion and technical rigidity; Discoid production is submitted to a recurrent rhythm with each series	technology is defined by the specific combination of four knapping domains subdivided into twelve knapping steps plus toolkit morphology; assemblage represents a palimpsest of technical options; the combination of the knapping domains provide information on a single generic reduction sequence; core technology is predominantly of a discoidal form with a clear tendency towards unifacial exploitation; platforms generally tend to be plain and relatively thick and exhibit moderately steep platform angles; core reduction is continuous and changes from (sub-)centripetal over unidirectional to crossed reduction modes; the assemblage is blank-dominated and blanks show relatively thick trapezoidal cross-sections and mostly parallel and/or expanding lateral edges; bifacial retouch and general Middle Palaeolithic tool types dominate; selection bias towards unidirectional blanks** and against pointed blanks; both cores and tools are heavily reduced; comparative data corroborates a technological profile of low laminarity and relatively twisted blanks; bifaciality probably matters in terms of tool production and not in terms of

	of removals struck from the same platform-surface and preparing the next series; Discoid cores provide high reduction potential; Discoid production is realised by two distinct methods; the two main directionalities of removal are tied to two distinct blank-types each; each blank-type is preferentially transformed into a designated set of tool-types; *façonnage* and *débitage* function as complementary blank-production systems but furnish blanks of different sizes (tool specialisation is tied to blank specialisation); *façonnage-débitage* interaction reflects a particular techno-logic; technical homogeneity and its implicated know-how (*savoir-faire*) constitute the signature of a distinct techno-cultural tradition	blank production; the specific combination of these parameters reflects a set of learned (socially transmitted) behaviours and as such a specific 'technological style' within the Central European regional sequence of technological developments between 60 and 30 kya

Tab. 2 **Juxtaposition of French and Anglophone interpretations of the same body of lithic artefacts. [* = see *supra*. ** = The finding that blanks with unidirectional scar patterns have been preferentially modified has been emphasised in Tostevin's (2000) original doctoral research but later omitted for unknown reasons (Tostevin 2012)] Even though the persistent difference in the number of distinct assertions between the two camps may be an analytical artefact, it also attests to the fact that Anglophone inquiry is built around the regulative ideas of simplicity and conciseness of argument**

	French conception	Anglophone conception
Data	focus on the verticality of data space (potentially steep, relational and hierarchised)	focus on the horizontality of data space (flat, *a priori* non-hierarchised, generic)
World	emphasis on the horizontality of the world (flat ontology, reality holism, blending of different reality domains, *pound-cake model*)	emphasis on the verticality of the world (ladder of inference, hierarchy of reality domains, metastructure-structure-substructure logic, *layer-cake model*)

Tab. 3 **Comparison of the dominant conceptualisation of 'data-space' and the nature of 'worldly order' in the French and Anglophone research enterprise. Note the complementary relationship between the horizontal and vertical focus in either of the two camps and their inversion across the data-world boundary. (All of these conceptual coordinates are explored in more detail in the subsequent sections and chapters; for the two opposing cake-models, see Appendix II.3)**

	Percentage of lithic artefact representations	Percentage of tables	Percentage of quantitative and/or statistical graphs	Percentage of abstract schematisations	Positioning of lithic artefact representations	Reliance on technical symbology	Standardisation of tables
Biache Saint Vaast IIA							
Boëda 1988	39.3	25	7.1	28.6	Main part of the analysis	Medium-high	Low
Dibble 1995a	16	56	28	-	Introduction	None	High
Gouzeaucourt G							
McPherron 1994	-	81	19	-	None	None	High
Soriano 2000	25	55	15	4	Main part of the analysis	High	Medium
Kulna 9a, 7*, 7c, 7a, 6b							
Boëda 1995a	60	-	-	40	Main part of the analysis	Medium-high	Low
Tostevin 2012	19	49	32	-	Appendix	None	High

Tab. 4 **Quantitative and qualitative differences in practices of image-use for each of the three paired case studies**. [*** = While Boëda has analysed all of the listed Micoquian layers from Kulna cave and interpreted them in their totality, Tostevin's examination includes only level 7.]**

Appendix I

Supplementary information on Chapter 1

I.1 **Terminology, definitions, and attribution of researchers**

Anglophone and French

The term 'Anglophone' is used deliberately vague and somewhat loose in this study. The reason for this is the – for historical and sociological reasons – highly interconnected nature of the English-speaking world in Palaeolithic research. As show in the main text, English-speaking practitioners share a great bulk of research concepts and ideas as well as identify similar persons as the great forefathers of their discipline. Even on the institutional level, similar terms are often used to designate the larger research enterprise, chairs, and/or departments. The term 'Anglophone,' as employed in the present study, refers to the totality of Old World Palaeolithic research conducted in the English-speaking world.

With 'English-speaking,' I exclusively refer to the national research traditions in which English is the native language. My usage of the term 'Anglophone' is narrower. I define it here primarily as comprising the United States of America and the United Kingdom. Research done in Australia and Canada is largely excluded from the analysis since it has developed along slightly different historical trajectories – for instance, these two countries do not rely heavily on the idea of 'palaeoanthropology' (*sensu* Clark and Howell 1966). Australian and Canadian scholars are sometimes nonetheless mentioned if necessary, but this is due to the fact that they have been educated in a relevant U.K. or U.S. university context – again pointing to the fact that the larger English-speaking world is strongly interconnected.[858] So, while I do acknowledge that there are some important differences between Palaeolithic research in the U.K. and the U.S., my main point in grouping them together for the purpose of this analysis is that they undoubtedly share what can be termed a 'discursive formation' and are able to engage into mutually meaningful debates. The results of my analysis confirm this assertion (indeed, Chapter 6 offers some poignant thoughts on why this is the case).

Yet, critical readers will perhaps stumble upon the *prima facie* apparent asymmetry between French and Anglophone research traditions since the latter – as we have seen – comprises more than one modern-day country. However, this asymmetry only exists at first glance since lithic analysis plays differential roles as a research practice in distinct national research-contexts. There is good reason to believe, for example, that the total amount of scholars that primarily contribute to the lithic research endeavour is roughly comparable between French and Anglophone contexts (whereas French Palaeolithic archaeology appears to be mainly driven by lithic inquiry, the Anglophone context is more mixed and multi-stranded and lithic analysis occupies a more ambiguous position there; see especially Chapter 1). There is also good reason to believe that the actual number of active scholars on the 'other' side is greatly underestimated by each tradition.

The term 'French' is used in a similar vein. It designates the aggregate of Old World Palaeolithic research conducted in the institutional context of French *« Préhistoire »*. Although national research contexts such as Belgium and Italy remain strongly influenced by ideas and approaches developed in France, and there clearly exists some permeability between these intellectual contexts, the present analysis focuses primarily on the French research-context *sensu stricto*, drawing on some of the relevant non-French scholars only if appropriate or necessary.

Above all, the signification of both terms is thus socio-historical. The attribution of individual scholars and the identification of larger constellations of research reflect this basic circumstance. The

[858] All of this casts light on the necessity to conduct a historical and sociological survey before selecting the units of analysis. Although this comprehensive survey cannot be presented here for reasons of scope, it remains a key prerequisite of the presented conceptual analysis and it should be kept in mind that socio-historical considerations hence always feed into the analytical decisions made in this work.

purpose of the following sub-sections is to outline the cornerstones of the therefore necessary socio-historical analysis preceding the epistemological inquiry which forms the core of the present work.

The attribution of individual scholars: approach and rationale

The designation of French and Anglophone researchers does not strive to be 'emic,' that is, to reflect their self-identification. Neither is it based on the type of passport one holds, or, more generally, the nationality of a scholar. Rather, the significance of 'French' and 'Anglophone' is purely of sociological and a product of the history of the discipline in France and the two 'Anglo-Saxon' home countries, the United States of America and Great Britain. Three main criteria were used to determine the place of an individual scholar on either side of the divide:

- **Participation in a legacy**: academic mentor(s)/teacher(s) and context of institutional training, especially during the formative period of the doctorate and, potentially, early post-doc phase; wider 'school' of thought; etc.
- **Position within a (positive) citation network**: the bibliographic space in which the researcher's work is situated and regularly taken up/referred to in a positive manner
- **Influence/importance in the two discursive formations**: initiation of key debates; training of key figures; institutional position; general place within the wider social web of a research tradition; etc.

In this way, some scholars may turn out to be irrelevant for the divide, of course, since their work forms part of a different current of Palaeolithic research.

Furthermore, the assignment of individual lithic researchers was guided by the construction of schematic 'sociograms,' visualising the relationship between individuals, different generations of scholars as well as particular institutional and personal legacies within two-dimensional space. These sociograms also clarify the socio-historical ties between the development of lithic research in the United States and the United Kingdom (for additional historical background, see Chapter 1 and **Appendix III.4**). The resulting social matrices do of course not exist in isolation, but their internal integrity is strong enough to warrant their separate treatment. Ultimately, the decisive factor for the attribution of a researcher is her/his overall position in a matrix. The attribution is consequently analytical and not just a matter of subjective verdict – considerable time and effort has been spent to perform the respective research and to do justice to the involved complexities.

Sociogram approach

The reconstruction of the three social matrices – French, U.S. American, and British – is based on three lines of research:

- **Extensive survey of doctoral dissertations**, especially with regards to the main supervisor(s), the configuration of the advisory committee, and the information given in the acknowledgements
- **Examination of institutional biographies of key players**, paying particular attention to horizontal developments in cognate fields at these institutions and potential influences from colleagues within Palaeolithic archaeology working there at the same time; entanglement with prestigious non-university organisations (e.g., national academies of science)
  [practically, this analysis comes close to a survey of key CVs and their socio-historical context]
- **Extensive survey of the historical background**, especially taking into consideration institutional histories, the histories of specific research groups and 'schools of thought' within the field, and the general currents of intellectual development in the three analysed contexts

The outcome of this research was complemented by and, if necessary, calibrated against, personal interviews and informal conversations with various lithic practitioners from both sides.

For the French research-context, historical background information was gathered from the following key sources, among others: Bordes 1968; Dauvois 1976; Schnapp 1980, 1993; Tixier et al. 1980; Audouze and Leroi-Gourhan 1981; Audouze 1999; 2002; Stoczkowski 1990, 1991, 1992a, 1992b, 1994, 1995, 2002; Julien 1991; Geneste 2010 [1991]; Pelegrin 1991, 2004, 2011; Schlanger 1991, 1994, 2004, 2005, 2012, 2015; Gallay 1991, 2003, 2011; Gallay et al. 1992; Soulier 1994, 2003, 2005, 2009, 2011, 2015; Coye 1997, 2005, 2006, 2015; Richard 1992; Debenath et al. 1992; Groenen 1994, 1996; Coudart 1999; Wisniewski 2003; Audouze and Schlanger 2004; Dubois and Bon 2006; Hurel 2007, 2011; Lippé 2007, 2010, 2012; Bidet 2007; Bon 2009; Djindjian 2009, 2013, 2016; de Villiers 2010; Delpech and Jaubert 2011; Hurel and Coye 2011; de Beaune 2011, 2016; Valentin 2011, 2015; Guillom-et-Malmassari 2012; Coye and Hurel 2013; Roux 2013; Loiseau 2014; Boissinot 2011, 2015; Plutniak 2015, 2016; Perlès 2016; Delage 2017; Audouze et al. 2017. In addition, the study draws on the insightful work of Ramírez-Galicia (2016), profiting especially form his comprehensive audio coverage of interviews with Parisian key players (18 interviews in total, cf. *ibid*.: 51f.).

For the Anglophone context of lithic research, the reconstruction of the historical background relies on the following key sources, among others: Willey and Phillips 1958; Howell 1963, 1972, 2003; Clark and Howell 1966; Tiger and Fox 1966; Lee and deVore 1968; Coles and Higgs 1969; Fox 1975; Higgs 1975; Barker and Dennell 1976; Schiffer 1976; Isaac 1977c; Meltzer 1979, 2011; Hammond et al. 1979; Reid 1980; Willey and Sabloff 1980; Cohn 1980; Daniel 1981; Binford and Sabloff 1982; Clark and Stafford 1982; Raab and Goodyear 1984; Wylie 1985, 2002; Clark 1986; Dunnell 1986; Bettinger 1987; Adams and Adams 1991; Nelson 1991; Sackett 1991, 2014; Clark 1991a, 2003; Walter 1993; Corruccini and Ciochon 1994; Mellars 1996; Bernbeck 1997; Chazan 1997, 2014; Clark and Willermet 1997; Trigger 1998, 2003, 2007 [1996]; Bailey 1999; Fagan 1999, 2005; Lyman and O'Brien 2000; Bleed 2001; Gamble 2001; Roebroeks and Corbey 2001; Schick and Toth 2001; Torrence 2001; Straus 2002a, 2007, 2017; Monigal 2002: 121-135; Shott 2003; Wendorf 2003; Shennan 2004, 2008; Corbey 2005; White 2007; O'Connor 2007; Sommer 2007, 2015; Díaz-Andreu 2007; Butzer and Klein 2007; Hudson 2008; Dibble 2008; Goodrum 2009, 2014; Wargo 2009; Freeman 2009; Shea and Lieberman 2009; Johnson 2010; Boyle et al. 2010; Sept and Pilbeam 2011; Abramiuk 2012; McNabb 2012a; Tostevin 2012; Lucas 2012; Van Reybrouck 2012; Klein 2013; Monnier and Missal 2014; Murray 2014, 2017; Kelly 2014; McCall 2015; Shea 2015; Mathewson 2016; Doolittle 2016; Dibble et al. 2017; Lycett and Shennan 2018.

This extended literature study included the close reading of obituaries/necrologies as well as introductory parts of relevant *Festschriften* or commemorative volumes.

Logic and notation of the graphs

The graphs are organised along two axes: the horizontal x-axis structures the sociological landscape of each research-context according to its key institutions, the vertical y-axis provides a rough and non-proportional measure of time, with the 'historical stream,' so to speak, proceeding from top to bottom. The smallest units are represented by individual scholars (small rectangular frames) which occupy specific positions within their associated institutional space-time grid.

Lines indicate personal influences of varying strength/importance (line weight), arrows express changes in institutional affiliation (new institutional positions are additionally highlighted by faded unit frames).

Frame-strengths indicate the relative centrality of researchers in developing or exposing their research-context; coloured frames stand for particular disciplinary inputs (e.g., economic theory, ecology, sociology, anthropology of techniques, etc.); special frame-shapes signal special/unusual socio-historical positions.

Graphs do not engross completeness. Instead, they serve as heuristic tools to contextualise and situate the work of individuals in terms of matrix-specific social and historical coordinates.

Note that the sociogram method greatly facilitates the analysis of individual cross-over and institutional exchange between national research contexts; it also enables the characterisation of particular social spaces of inquiry in terms of their organisational centrality and de-centrality. Moreover, the resulting matrices can be examined in terms of their general permeability and internationality, but also in terms of their structural conservativism, if any.

Results

Each of the three reconstructed sociograms is presented separately below, starting with the French case and followed by the U.K. and U.S. examples. As a disclaimer, the reader should keep in mind that the overarching goal here was not completeness, but the recognition of structural features in the social organisation of lithic research and the informed placement of the case study protagonists into their proper socio-historical context(s).

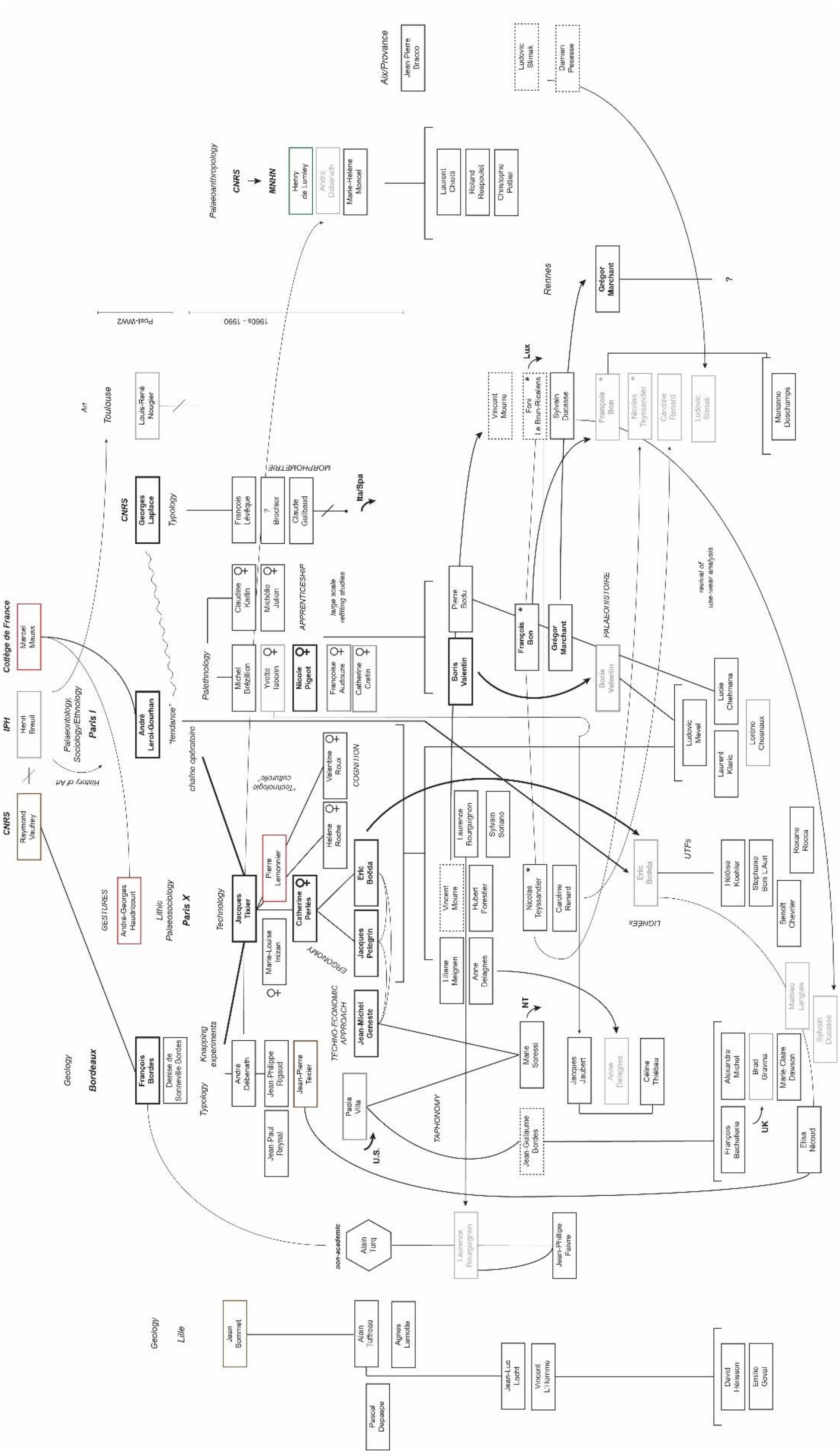


Fig. I.1 **Reconstructed socio-historical matrix of the French tradition of lithic research. Note the centrifugal organisation and the importance of a limited number of innovative centres as well as their cognitive division of labour.**

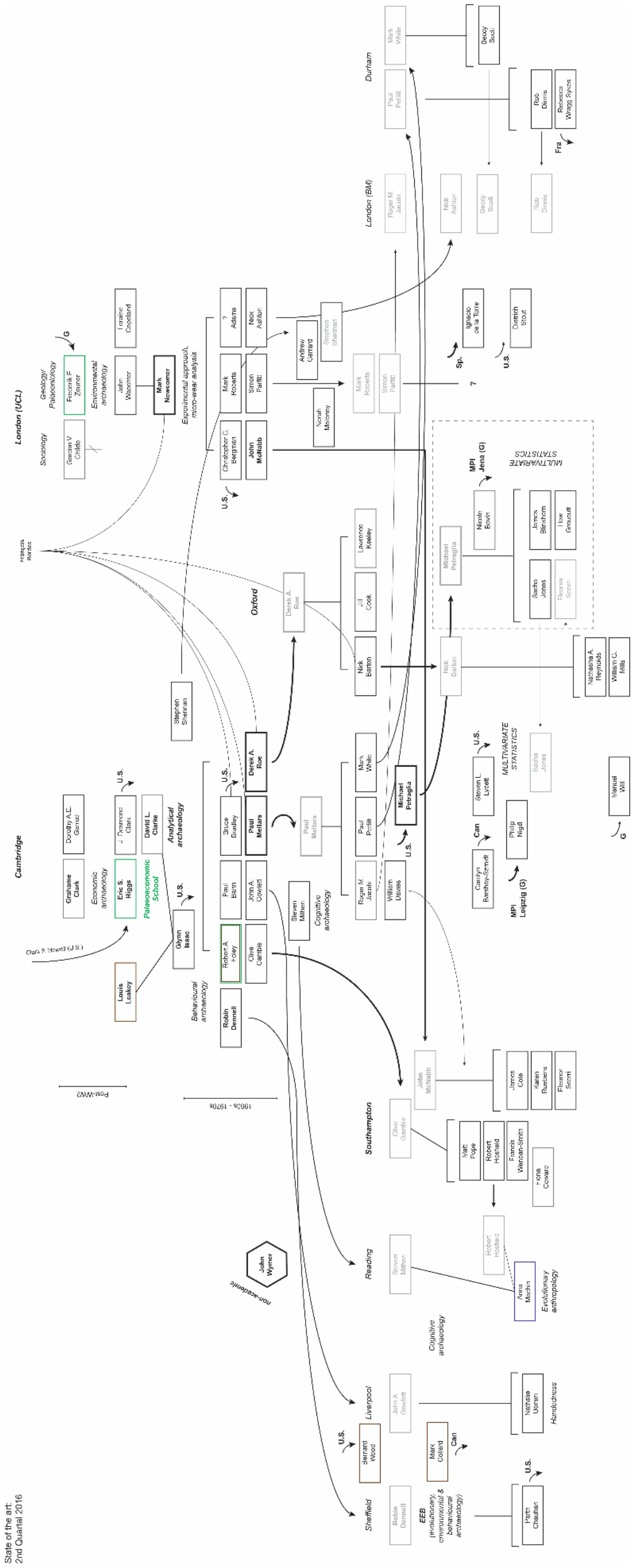
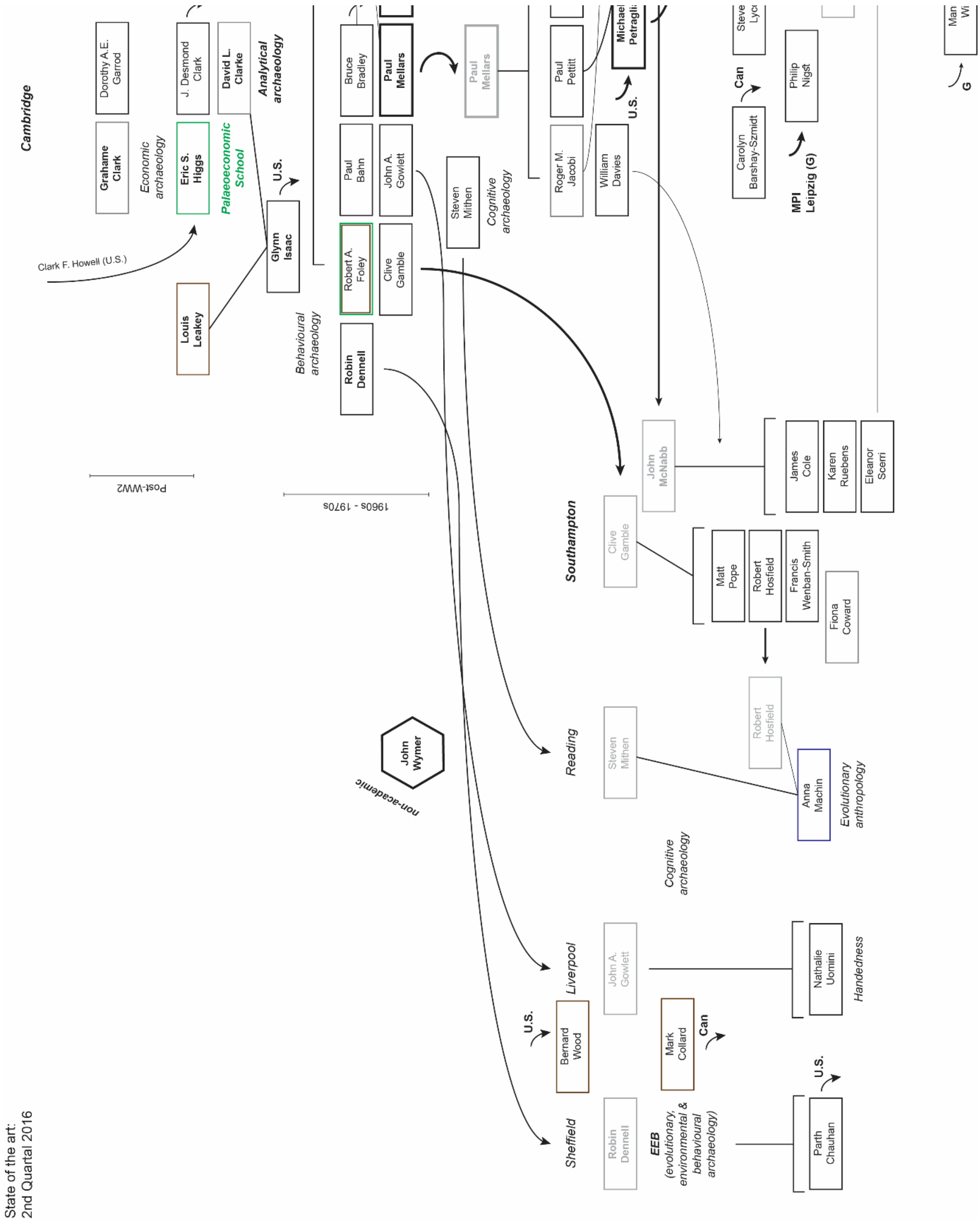
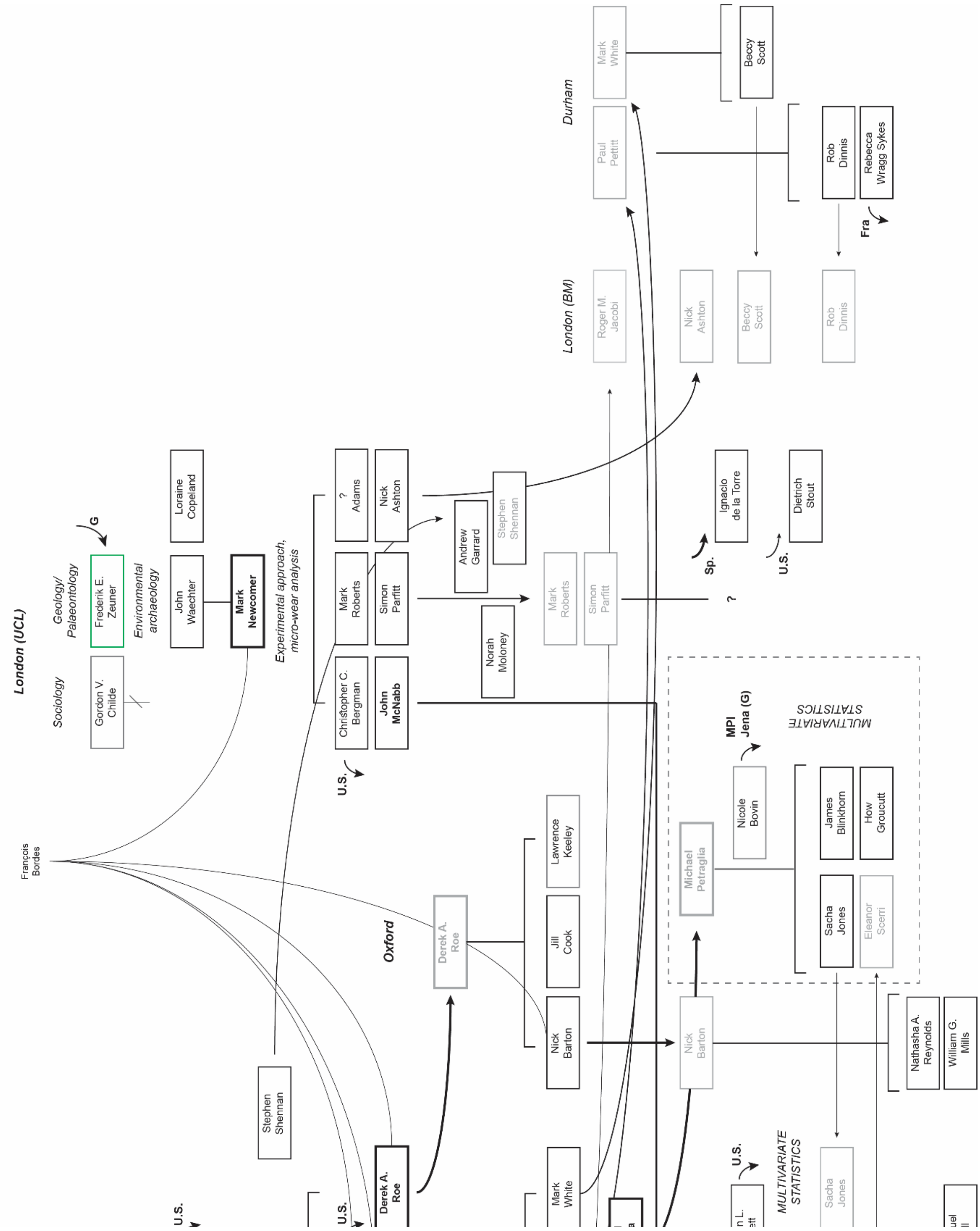


Fig. I.2 Overview of the reconstructed socio-historical matrix of British lithic research. Note the latent influence of François Bordes, the foundational duality between Cambridge and London, as well as the currently ongoing institutional diversification of research. Close-ups are provided below.

Left section of Fig. I.2 **(magnification)**



Right section of Fig. I.2 **(magnification)**



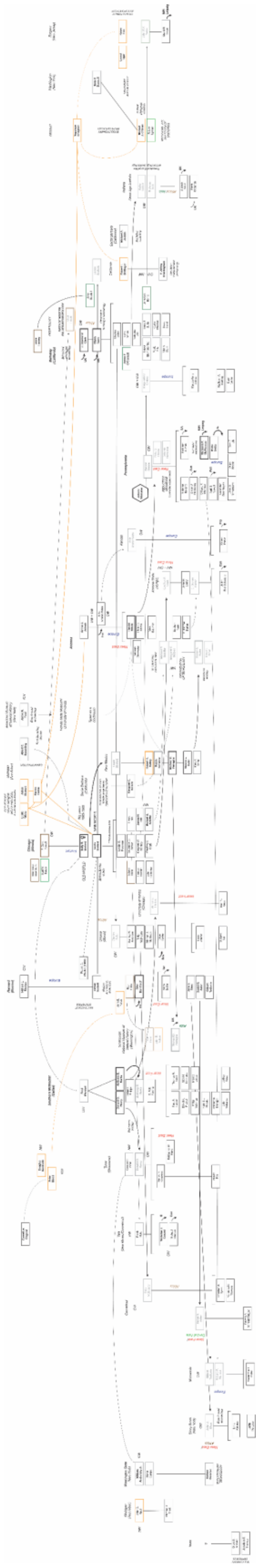
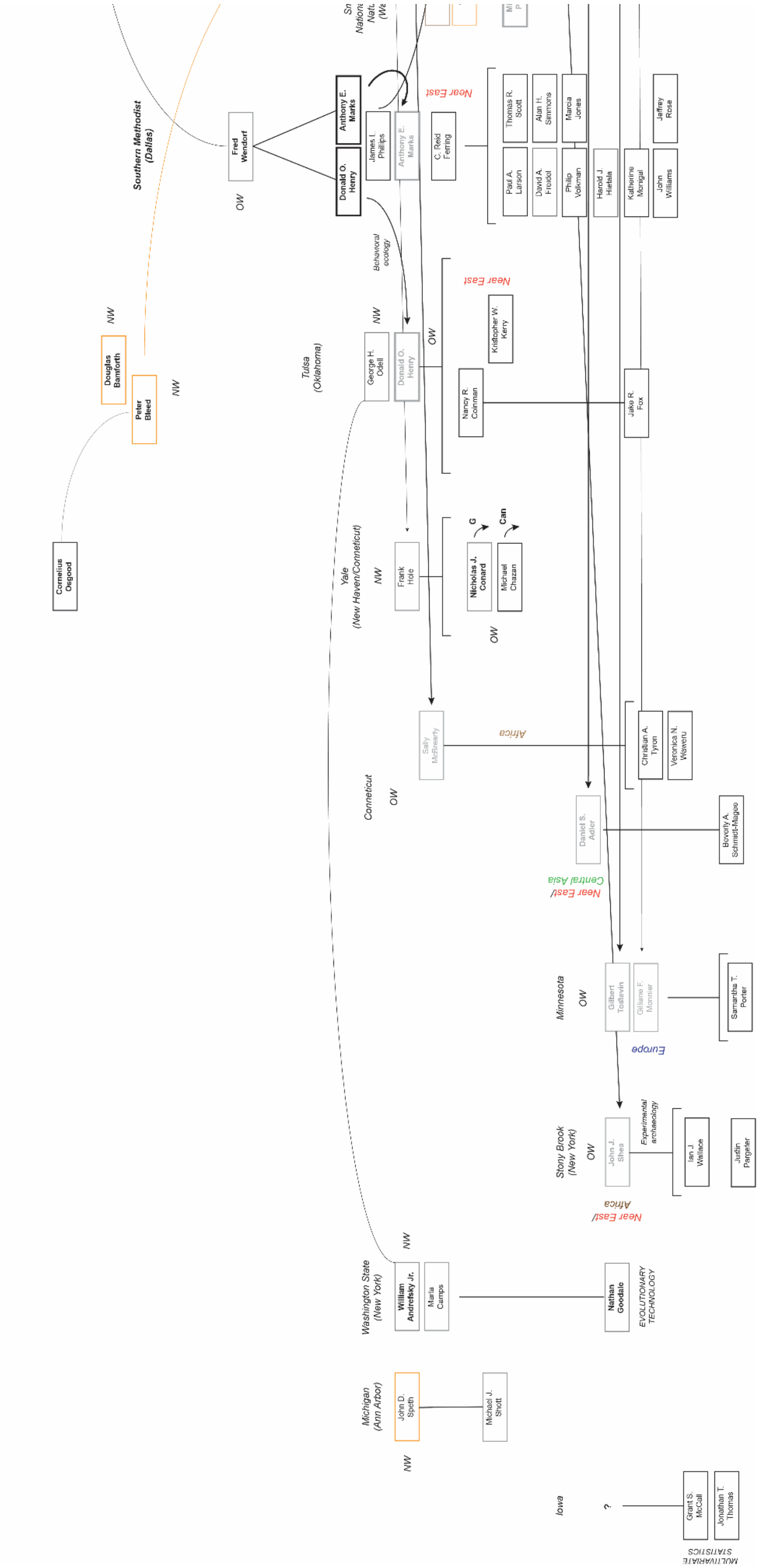
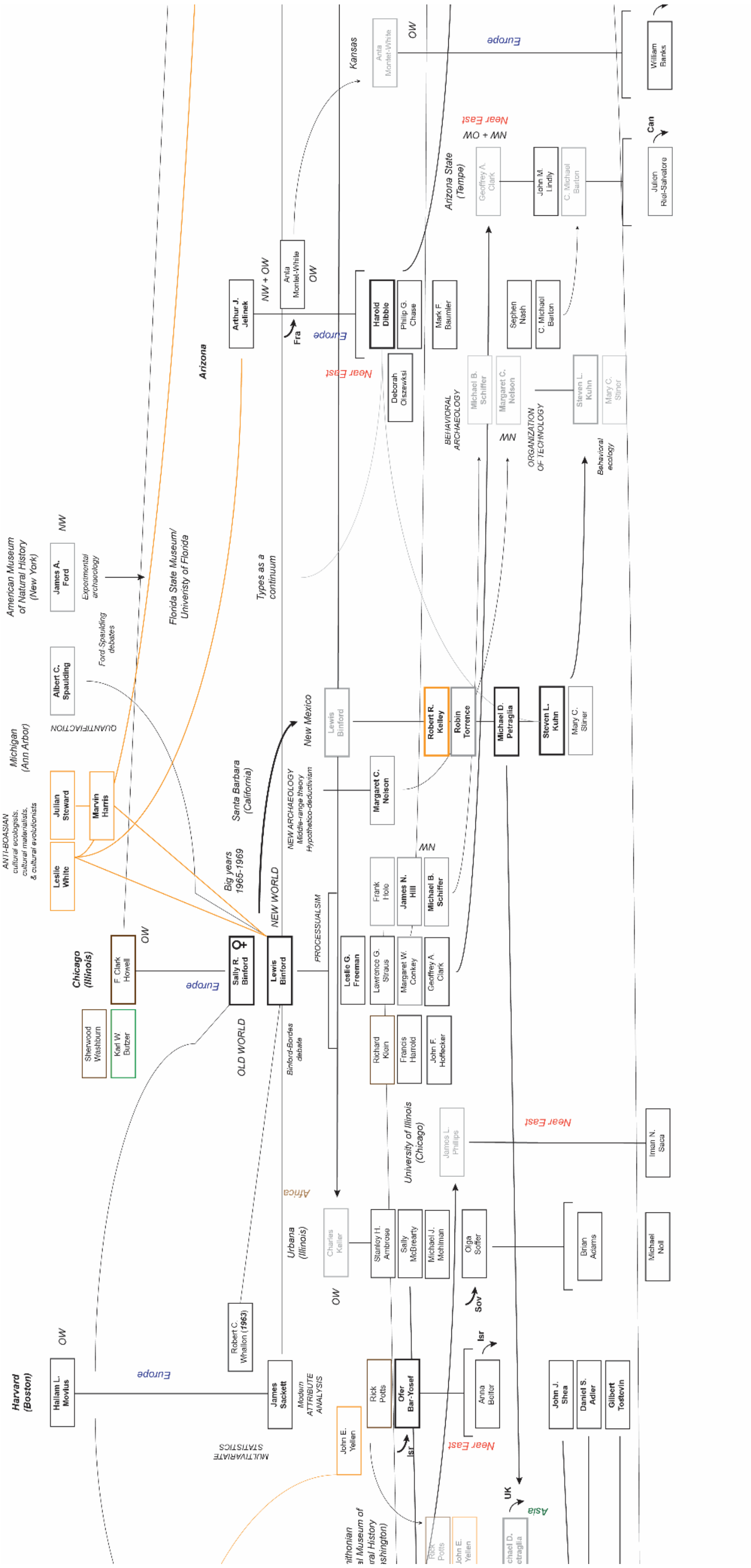


Fig. I.3 **Overview of the reconstructed socio-historical matrix of lithic research in the United States. Note the branching and strongly diversified organisational structure with multiple institutional foci of research, often with regional research specialisations; note also the tension between Old World (OW) and New World (NW) research backgrounds. Close-ups are provided below.**

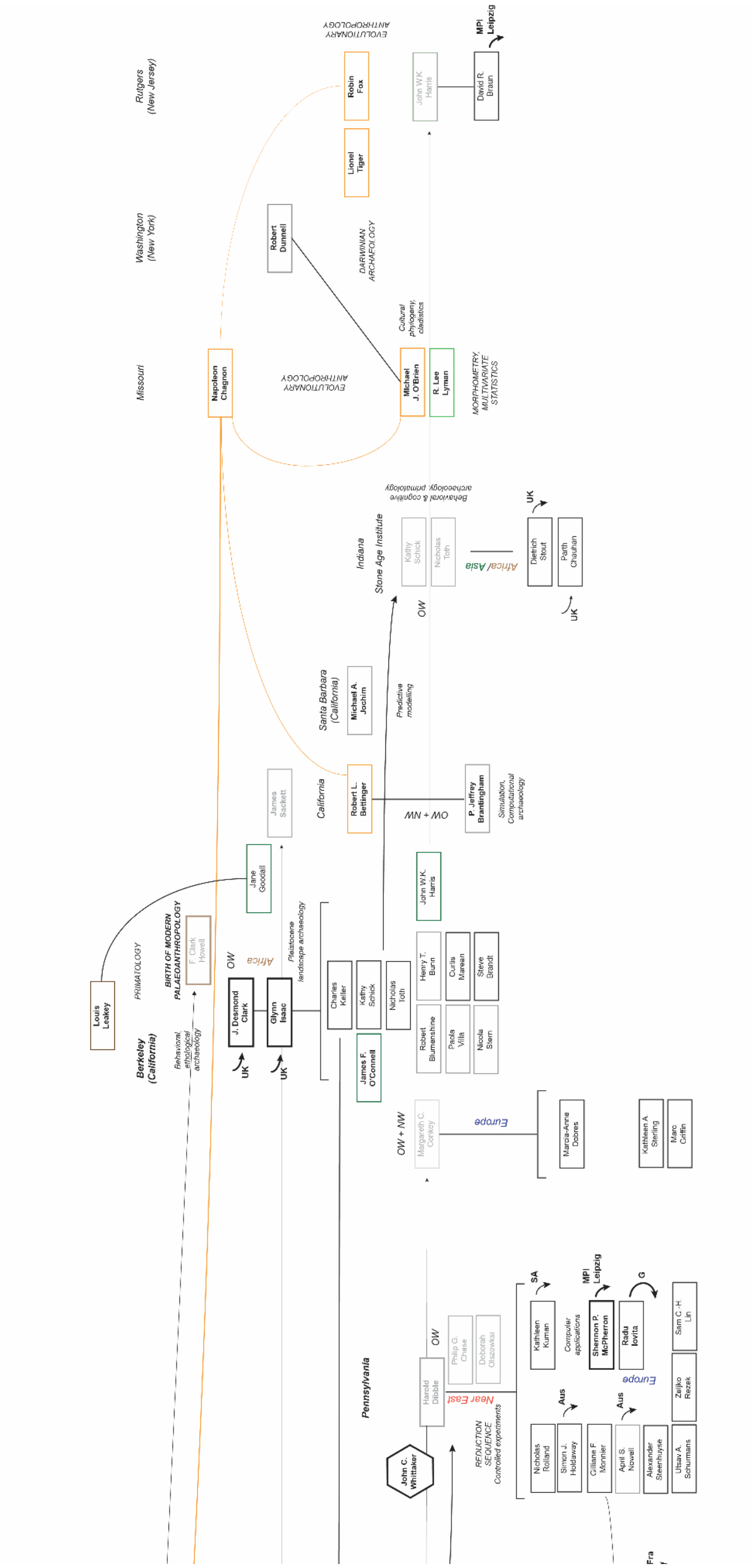
Left section of Fig. I.3 **(magnification)**



Middle section of Fig. I.3 **(magnification)**



Right section of Fig. I.3 **(magnification)**



I.2 **Selection of the three primary case studies and their significance**

The problem of using historical case studies

All case studies are necessary historical – they naturally derive from a historical context and both thematise and entail this context. Adopting such case studies for analytical, argumentative, and/or demonstrative purposes prompts what Joseph Pitt (2001) once baptised 'the dilemma of case studies'. In general, this problem consists of the difficulty to avoid either falling prey to a certain *selection bias* or to become persuaded to *overgeneralise* from a single case (cf. Currie 2015). In philosophical terms, the problem consists of consolidating what in the Anglophone world is known as the 'philosophy of science' and the 'history of science'. This, in turn, breaks down into whether the role of utilised case studies is conceived primarily in 'conceptual' or in 'historical' terms. The general problem is that none of the two can do its work without taking the other seriously. In other words: if we want to defend, demonstrate, or illustrate a certain conceptual claim – for instance that certain groups of scholars tend to produce certain types of results – the question is always whether the chosen cases are really representative or whether they simply serve the analytical intention in a satisfactorily manner; if one starts from history, the problem is not necessarily smaller since there is always the risk of 'forcing' a conceptual claim onto a historical context. Also, the historical perspective makes it especially difficult to derive any case-transgressive finding since each case of course reflects its historical situatedness. For these reasons it is so fundamental to specify the grounds of case study selection and to discuss what kind of insights they enable.

My general strategy is to follow Scholl and Rätz (2011: 75), who consider concepts drawn from philosophy as rather *abstract* and generalised entities whereas 'historical facts' (and case studies are such historical facts) can be seen as *particulars*. This allows us to conceive the relationship between historical cases and philosophical concepts in a more pragmatic and less problem-infused manner. Because of their abstractness and generality, philosophical concepts cannot be expected to be fully exemplified by historical cases. Rather, they tend to be instantiated and interpreted to various degrees by different historical research contexts. This is the co-constitutive relationship between historical framing and conceptual significance that forms the basis of the present study. As Giere (2011: 60f.), for instance, puts it: the analysis of general concepts should allow for the elaboration of a general *theory of science* – such a theory is provided by Pepper's world hypotheses perspective described in Chapter 2; this theory, however, is also in need of confrontation with actual cases of *scientific practice*. Distinguishing between general theoretical dimensions of science and particular historically situated practices helps to deflect the 'fallacy of normativity' – the temptation to search for standards of science which lie outside of the practical realities of science. The premise is that the power of concepts can only be evaluated by confronting them with how (if at all) they operate in specific historical cases, and not independently of such a context.

Selection of the three case studies in relation to case-study types

The general rationale of selecting cases has been the following: the *constants* of these case studies were defined as lithic assemblages, while the *variables* were defined as scholars and their conceptual resources. This is because the aim of the comparison was to investigate how differences in approach effect (if at all) the interpretation of the *same collection of lithic artefacts*. In other words: whether the conceptual resources of scholars had an impact on what they could learn from these collections and how big this impact was. Keeping the factor of lithic assemblages constant makes it thereby easier to focalise on the most important disparities that emerge at different steps in the research process.

As laid out in some detail in Chapter 1, all of the selected case studies originate from the period between the 1980s and the early 2000s. This is not coincidental since this is precisely the formative period for both current-day French and Anglophone lithic research endeavours.

The representativity of the cases is more difficult to assess. This has primarily to do with the fact that there was only little choice involved in selecting them. Finding a single assemblage which has been studied to a sufficient extent by at least one scholar with a solid French and by another scholar with a solid Anglophone research background is difficult to meet in practice. This situation is a result of unfortunate site and assemblage 'protectionism' – a practice as old as archaeology itself. Yet, that particular sites continue to be studied by particular scholars is also the result of different sites playing different roles in different discursive fields and narratives. The epistemic interest to re-study a given assemblage from another perspective is thus practically often limited.

Having said this, the three case studies mobilised in Chapter 1 and 3 were the only ones that I could find in the literature meeting all the mentioned requirements. This fact has a negative and a positive consequence. Negative is that the selection of cases might by rather arbitrary and that there may be some redundancy due to this (e.g., Boëda features twice). Positive, however, is that their selection was not dependent on a particular thesis to be defended since the selection was guided by maximally pragmatic considerations. One can in fact interpret this pragmatic selection as a form of 'auto-randomisation.'

To clarify the nature of cases, it is helpful to draw on the taxonomy of historical case-types established by Scholl and Rätz (2016: 77-86, 82-83). According to these authors, one can at least distinguish between four main categories of case studies, each of them tied to a distinct informative value: (i) *Hard cases*; (ii) *Paradigm cases*; (iii) *Big cases*; and (iv) *Randomised cases*. The first category of case studies, 'hard cases,' is typically selected to challenge conceptual claims, not to illustrate them; cases that violate expectations or standard views and that are generally difficult to accommodate are looked for in this category. The second category, 'paradigm cases,' is usually mobilised to exemplify more or less typical instances of the type of science or field under consideration; cases selected here have become some sort of role models for how their particular science works – they are often regarded as guiding examples for their peers, showcasing how one ought to do a particular kind of analysis. The identification of 'paradigm cases' therefore requires some support from historical research. 'Big cases' typically thematise some important scientific achievements in a given discipline or field; this may or may not include that these cases have given rise or motivated specific (new) branches of research or acted as a template for a substantial number of further work – some of these factors may bring them rather close to 'paradigm cases'. The main concern of using 'big cases' is their generalisability. 'Randomised cases,' finally, are selected by some sort of sampling mechanism to avoid any form of selection bias.

From the exposition of the three chosen case studies in Chapter 1, it becomes clear that most of them are 'big cases' while some are likely also 'paradigm cases' (**Table I.1**). Whether any case study is 'hard' primarily depends on the questions one wishes to ask. They are, for example, clearly 'hard cases' if we wish to ask whether lithic technology can be comprehensively studied with a single method, say the 'Scientific Method.' Because my main motivation was to select cases that are able to thematise the strength of evidential constraints and the role of conceptual framing in lithic analysis, all of them are also 'hard cases' in order to evaluate the intuition that scientific results in Palaeolithic archaeology are primarily constrained by the objects of study themselves. Most selected cases are also 'paradigmatic' for their respective research sphere for at least one important reason. Although it could, for instance, be generally questioned whether Dibble and Boëda are representative figures for their research traditions, (mainly because of the radicality of their opinion and approach), they can still tell us something very important. I would indeed argue that their 'boundary status' is precisely what renders them so illuminating. By pushing the basic epistemology of their research contexts to the limits and by challenging it, boundary cases reflect how particular approaches tend to accentuate, refine, and/or re-negotiate their conceptual core. Extremes therefore help us to better understand what is 'ordinary' in the research context they originate from and talk about. In other words, extremists can serve as ideal-types for their respective research backgrounds, in this way becoming 'paradigm cases;' they tell us something about the epistemic potentials and possibilities of the modes of cognition they generally harness. The fact that they sometimes 'overstate' their research epistemology allows us to better recognise what this epistemology is all about – a condition that is analytically exploited here.

Assemblage(s)	Case-type	Authors
Biache Saint-Vaast IIA	paradigm, big	Boëda 1988; Dibble 1995a
Gouzeaucourt G	big	McPherron 1994; Soriano 2000
Kulna 9b, 7, 7c, 7a and 6b	big?/paradigm?	Boëda 1995a; Tostevin 2000, 2012

Table I.1 **The three chosen assemblage-based case studies and their epistemological status according to the typology of historical case-studies by Scholl and Rätz (2016).**

I.3 The journal landscape at the French-Anglophone interface

The following table provides an overview of the most notable scientific journals (including a selection of important but non-ranked journals in the French case) in which the results of French and Anglophone lithic research are commonly published.

Main French journals	SJR Rank indicator
Comptes Rendus Palevol	0.733
Bulletin de la Société préhistorique française	0.662
L'anthropologie	0.492
Paléo	-
Gallia préhistoire	0.166
Techniques & Culture	-
Paléorient	-
P@lethnology – bilingual review of prehistory	-
ArcheoSciences	0.104
Main Anglophone journals	
Quaternary Science Reviews [UK]	2.81
Journal of Human Evolution [US]	2.754
Journal of Archaeological Research [US]	2.61
Journal of Archaeological Science [US]	1.982
Journal of Archaeological Method and Theory [US]	1.896
Journal of World Prehistory [US]	1.579
Current Anthropology [US]	1.549
Journal of Anthropological Archaeology [US]	1.505
Evolutionary Anthropology [US]	1.492
PloS ONE [US]	1.201
American Antiquity [US]	1.192
World Archaeology [UK]	1.137
Quaternary International [UK]	1.096
Antiquity [UK]	1.06
Geoarchaeology [US]	0.988
Archaeometry [UK]	0.968
Cambridge Archaeological Journal [UK]	0.929
Journal of Field Archaeology [UK]	0.728

Archaeological Dialogues [UK]	0.689
Environmental Archaeology [UK]	0.650
Lithic Technology [UK]	0.648

Tab. I.2 **Tabulation of the most important journals for French and the Anglophone Palaeolithic archaeology. Note that this list is not exhaustive but intended to showcase the overarching patterns. SJR Rank Indicator after International Scientific Journal and Country Rankings 2016 is used as a proxy for relative impact factor. Nature and Science have deliberately been excluded although one may argue that Anglophone research tends to be more sucessful at publishing in the two.**

Appendix II

Supplementary information on Chapter 2

II.1 **World hypothesis theory as a method for conceptual analysis**

From a methodological perspective, the strength of Pepper's meta-theoretical framework is twofold: it (a) provides a general taxonomy to capture the full spectrum of epistemological stances present in lithic analysis, and it (b) specifies and elaborates an inventory of structural categories and concepts which characterise these stances. This is of great methodological interest since it helps to disentangle the multi-paradigmatic and multi-stranded nature of the lithic research enterprise and to focalise the common trends and fundamental rifts in a goal-oriented manner. Specifically, (a) allows to clarify the general epistemological structure of lithic studies and how it relates to differences in research traditions and other social factors; it enables the comparison of basic strategies of knowledge production with socio-historically distinct context of knowledge-formation. Complementarily, (b) helps to understand how knowledge production in a given epistemological context works, and greatly facilitates the identification of key concepts in the analysis of case studies; Pepper's structural categories can guide the analysis of lithic knowledge production in these cases and allow us to better comprehend the role and significance of the various methods, theories, concepts, and data mobilised.

The utilisation of Pepper's meta-theoretical categories is primarily pragmatically motivated, even though the present author believes that the high epistemic success of mapping them onto lithic research practices at the French-Anglophone interface also warrants their ontological reading (cf. Chapter 6). In any case, Pepper's categories allow us to speak about similarities and differences in lithic practice in a problem-oriented manner and without getting lost in intricacies and details; the categories also enable to distinguish more effectively between levels of conceptual significance and between significance in terms of intra-theoretical variability and inter-theoretical diversity as well as between necessary categories ('conceptual core') and derived or supplementary categories ('conceptual jacket').

It has to be noted, however, that, although I present most of the structural categories that Pepper identifies for each of the four world hypotheses, I have also tried to tailor them to my needs. This means that I have translated some of the concepts by pointing out some of their most important research consequences or methodological correlates within lithic research. I hope that this makes it easier for the reader to follow my line of reasoning and to recognise the significance of the mobilised concepts. For this reason, the description of the conceptual space of each world theory already anticipates (at least partly) what is to follow in the conceptual analysis of the case studies.

The perhaps most important purpose of Pepper's meta-theoretical framework is that it provides meaning to otherwise isolated features of research; it helps us to understand how structural categories and concepts relate to one another, how they are imbricated in a particular theory of cognitive criticism, how this affects the construction and handling of data, and the ways these are ultimately connected. As the present study hopes to show, these interrelationships are crucial to understand if we wish to develop an instructive epistemology of lithic knowledge production.

II.2 **Detailed exposition of the relative weakness and cognitive inadequacies of the four credible world theories**

Due to the strict *cognitive autonomy* of world hypotheses (Pepper 1942: 98), a world theory's inherent difficulties, possible partialities, weaknesses, and/or inadequacies cannot legitimately be judged from the perspective of the rival theories, even if these turn out to be relatively adequate in their own right (cf. *ibid.*: 115). Rival theories may render us 'sensitive' for particular problems that a theory faces and may help to identify or point to these problems, but they cannot criticise them effectively since they can only do so from their own vantage point.

That even the four relatively adequate world theories carry some serious sources of inadequacy must thus be shown by *internal analysis* – by a demonstration that these difficulties arise out of the structural categories proper to each theory. In Pepper's (1942: 115) own words, a world theory must "convict itself of inadequacy" and often does so in the course of its historical development when scholars try to clarify and/or refine its structural categories. The more obvious structural inadequacies of each theory provide a constant incentive to develop various forms of eclecticism; these are, as Pepper notes, well-attested in Western intellectual history.

General difficulties with 'dispersive' and 'integrative' theories

The most basic inadequacies of the four relatively adequate world theories derive from the 'dispersive'-'integrative' polarity of world hypotheses; they are an immediate consequence of the necessary trade-offs between these two poles of global conceptualisation.

'Dispersive' theories, as we have seen in Chapter 2, face no difficulties in taking all facts seriously that are available to them but generally lack in precision. 'Dispersivity,' therefore, often puts scholars into a position in which they have to deal with a range of equally consistent interpretations to which their facts are amendable (Pepper 1942: 144). Since it is difficult for these theories to explain away any 'facts,' they need to find ways to narrow down how these can be interpreted and to constrain the effects of differential emphasis. This is the price of sustaining a 'high explanatory coverage' of facts. The sheer amount of factual information that 'dispersive' world theories have to process simply hampers their ability to give a precise explanation for all of them. They have difficulty with providing focus and tend to offer general types of explanations whose connection to the observed factual configurations is often loose at best.

'Integrative' theories, on the other hand, face the exact opposite difficulty. Their strength is to ensure precision but they lack in scope. This typically means that they have to explain away facts that they consider irrelevant or detrimental to the explanation of a phenomenon – in Pepper's (1942: 145) terms, they are constantly "tempted to throw "facts" out into the "unreal" and by whishing perhaps too hard to get everything into one determinate order, they have to deny the reality of a good many things." This is why 'integrative' world theories tend to distort and truncate reality – they have a tendency to reduce the richness of worldly experience and to make a lot, probably too much, out of the idea that some things may be illusionary and exist only in appearance.

We can generally state that 'integrative' world theories tend to overestimate the role and degree of order that persists in reality; they presume that order is categorical, typically implying that some facts are more relevant than others for explanatory purposes (i.e., overemphasis of 'directed' and 'strong' determination). 'Dispersive' world theories, to the contrary, tend to underestimate the role and degree of order (i.e., overemphasis of 'pluri-directed' and 'weak' determination), yet paradoxically often overestimate the world's latitudinal interconnectivity – that is, that all facts are potentially equally important for explaining whatever needs to be explained. The latter is perhaps especially pronounced within 'contextualistic' modes of inquiry.

General difficulties with 'analytic' and 'synthetic' theories

A similar type of distortion is likely associated with the trade-off between 'analytic' and 'synthetic' world theories; both types of world theories are inconsistent with our intuition that the world affords a rich spectrum of experience and knowledge.

'Analytic' world theories, as we have seen in Chapter 2, place primary emphasis on parts and thereby reduce wholes to be compositional features of reality; this, again, tends to result in the denial of independent existence of wholes although common-sense experience tells us that wholeness is a highly effective feature of reality. It is likely that something of importance gets lost in this approach.

'Synthetic' theories face a similar problem: they likely over-emphasise wholeness and the existential dependency of parts on wholes; these theories hence gravitate towards rejecting the explanatory value of isolated parts and recast them as merely derivative. They additionally face the difficulty of reaching out to the wholes they aim to describe and explain, since they have to insist that these are ‘more’ than the sum of their parts.

We can generally state that ‘synthetic’ world theories tend to over-complexify matters in reality, whereas ‘analytic’ theories tend to over-simplify them. The point is that in ‘synthetic’ approaches ‘complexification’ is typically a methodological manoeuvre to detail part-whole relationships; in ‘analytic’ inquiry, complementarily, ‘simplification’ serves as a tool to demonstrate that the character of a whole follows from the characters of its parts, without any substantial loss. The over-complexification of largely synchronic relations is characteristic for ‘contextualism,’ while the over-complexification of temporal-diachronic relations seems diagnostic for ‘organicism.’ Over-simplification in ‘formism’ typically concerns the link between ‘subsistence’ and ‘existence,’ while in ‘mechanism’ it seem to be a consequence of pinning down fixed causal structures.

Inadequacies of formism

The problem of ‘ties’

According to Pepper (1942: 155f.), a prime source of inadequacy in formism is likely rooted in the distinction between relations and ‘ties’ (see Chapter 2: **Box 6** for an explanation of these concepts in formism); the two, in Pepper’s eyes, are regularly confused and this, in turn, creates major inconsistencies which threaten to bring down the theory altogether. The imperative nature of the relation-‘tie’ distinction is a consequence of the basic categories of ‘immanent formism and I will shortly reconstruct them here to expose the difficulty.

In ‘immanent formism,’ we can distinguish between (i) ‘characters’, (ii) ‘particulars’, and (iii) ‘participation’. The crucial concept is ‘characters’ since these describe the qualities attached to particulars and the relations among these qualities (Pepper 1942: 154). The difference between characters and particulars is that distinct particulars can have the same characters; furthermore, some qualities are preclusive to one another – for a particular which is blue cannot be red at the same time, except for it being “bluered” but this would be another character altogether (*ibid.*: 155). This implies that characters logically involve relations among qualities. Now, since ‘ties’ in formism are defined as specific combinations of characters and particulars, that is, as character-particular relationships, ‘ties’ appear to represent some sort of second-order relations. Here the confusion begins. As Pepper (*ibid.*: 155f.) points out: “[t]ies are [thus] relations which are not relations. This sounds very much like a self-contradiction, and seems to indicate a categorical inadequacy. I rather think it is.” At the very least, to distinguish between ‘ties’ and relations turns out to be very difficult in empirical research. The distinction, however, must be defended since (dis-)similarity, the root-metaphor of formism, is not gauged as a relation but rather as a ‘tie’ (*ibid.*: 156).

Moreover, the relation-‘tie’ distinction turns out to be substantial in formism since one of its main instruments, the ‘Theory of Types’, appears to be a logical systematisation of this differentiation (Pepper 1942: 158). If the distinction is not uphold, in other words, formistic typologies run into the danger of becoming empty, i.e., ‘meaningless’ abstractions. Following Pepper (*ibid.*: 156), the ‘Theory of Types’ relies on the principle that the concepts which are employed to analyse other concepts cannot themselves be included in the concepts analysed. Although this statements appears to be perfectly sound, it immediately unmasks a potential source of incompleteness in formism; from the logical principle it follows that descriptions of the world as a whole are meaningless – a typical credo of modern positivists as Pepper says – because we need to employ concepts which themselves are withdrawn from analysis. For this reason, analysis can never include the totality of fact and this means that formism is potentially self-undermining as a world theory. From this perspective, the ‘Theory of Types’ can be understood as a formula which tells us which concepts can be safely employed and which need to be excluded from the analysis to avoid conceptual trouble (*ibid.*: 158). At its heart, it tells us to not confuse relations and ‘ties’ as they are constructed and interpreted in formism. It is for this reason that the ‘Theory of Types’ presupposes the formistic world theory – the logical principle it rests on can thus not be mobilised to show that ‘synthetic’ world theories are fallible. Moreover, it presupposes the very difficulties it was proposed to solve – it merely helps navigating the distinction between relations and ‘ties’. This, according to Pepper (*idem*), is mere “hypostatisation.” He adds (*ibid.*: 158f.): “[the ‘Theory of Types’] probably represents an irremediable inadequacy within the formistic world theory, and points to a region where the theory in terms of its own logic confesses its inadequacy.”

The central tool in formism to bring order to the world, *classification*, is particularly susceptible to pave the ground for categorical self-contradiction (cf. Pepper 1942: 161). The reason is that classifications and the delineation of classes are usually dependent on the ‘Theory of Types’. Formism faces problems when talking about all of its particulars at once because then all particulars, strictly speaking, do belong to no class, they simply form the category of all particulars. If the intuition of similarity on which formism rests is correct, this category must possess no character by definition. But this reveals a potential contradiction, for something having no character cannot be true, since having the character of no character appears to be self-contradictory (*idem*). A similar problem is faced when formism attempts to foster its grip on a single particular which has no class either (for a class cannot be defined by self-identity but by ‘ties’). The difficulty is that a class, in the end, cannot be defined by characters, particulars, and/or participation alone and also cannot constitute a separate category of itself; it is simply the operation of all of the three formistic categories and as such completely analysable into the functioning of those categories (*ibid.*: 162). Classification, too, needs to assure the conceptual and operative distinction between its categories, again showing that relations and ‘ties’ must not be confused.

The problem of ‘subsistence’

A second source of relative weakness results from the practical implementation of the distinction between ‘existence’ and ‘subsistence’ which is fundamental to formistic explanations (cf. Chapter 2: **Box 6**). The acceptance of ‘subsistent’ categories which are not fully ‘particularisable’ predisposes formists to quickly adopt standard interpretations of patterns and/or types of evidence grouped into particular classes, i.e., interpretations that mobilise *conventional* ‘subsistent’ categories. This is to say that explaining by ‘subsistence’ is particularly vulnerable to accept readings which are *en vogue*. (This goes hand in hand with the difficulty in formism to forcefully differentiate between different readings of equally amendable sets of facts). Another side of essentially the same difficulty is the tendency to apply abductive reasoning (reasoning according to the simplest explanation) informed by earlier research to make sense of the evidence. ‘Subsistent’ categories, in other words, are often too quickly and too uncritically extrapolated from one area of inquiry into another in order to explain what is observed there. Interpretation then becomes a question of evaluating the plausibility of particular ‘subsistent’ candidates themselves and is hence threatened to become critically detached from the actually available evidence – from the realm of ‘existence’.

The inherent tension between ‘analyticity’ and ‘subsistence’ in formism is also troublesome and may be another source of self-contradiction. As an ‘analytic’ world theory, formism assumes that the world is fully analysable into its parts, but practically admits that some features are not for these *subsist* (Pepper 1942: 168f.). Especially when the category of ‘subsistence’ is interpreted as being made up by ‘second-order particulars’ (cf. Chapter 2: **Box 6**), ‘subsistence’ turns out to be not fully ‘particularisable,’ which is another way of saying that it is not fully analysable into elementary characters (*ibid.*: 169). ‘Subsistent’ entities in this sense, e.g., formistic norms and laws, are precisely those which are defined as *complex* characters and patterns (*Gestalts*), or as combinations of the two (*idem*).

In general, the stipulation of some particulars as the most basic ones threatens to collapse formism and to transform it into a ‘mechanism’ in disguise. This is perhaps most evident in the case of space and time which tend to be conceptualised as basic particulars by formists (Pepper 1942: 174). Not only is the problem of ‘ties’ aggravated by this manoeuvre (*idem*), it also undermines the distinction between ‘existence’ and ‘subsistence’ because space and time – *qua* basic particulars – are then recast as structural features of concrete reality, and therefore find themselves within the realm of ‘existence’ which of course conflicts with their proposed ‘subsistent’ status.

The problem of discreteness

The perhaps most severe conceptual weakness of formism derives from its basic assumption of *discreteness*. This assumption is so essential that abandoning it would lead to a full collapse of the theory and in fact marks the gateway to 'mechanism' (Pepper 1942: 184) – this is also part of the trouble of recasting space and time as basic features of reality for it easily leads to the conception of a determinative spatiotemporal field, a conception proper to 'mechanism'. Conversely, formism asserts, by virtue of its structural categories, that the world is hold together by a number of discrete and therefore separate laws, norms, and/or regularities; the possibility for integrating them into a single structure or system poses a constant threat to undermining the validity of the theory (*idem*). Formism consequently has to invest cognitive resources to secure the discreteness and fragmentation of nature and must *in principle* insist on an incomplete integration of facts; the problem is that formism cannot demonstrate that such integration is impossible and hence relies on negative, mainly illustrative arguments. This translates into a general weakness of 'dispersive' theories outlined before: "[their] looseness in categorical structure and consequent lack of determinateness" (*ibid*.: 185).

A consequence of this categorical 'looseness' is that according to formism, there is no definite or finite number of entities, classes, or categories to be found in the world; in order to answer questions like "what constitutes one particular, or one character, or one norm or law?" or "[h]ow many particulars are there in a sheet of paper?," "[h]ow many in the flight of an airplane?," and "[h]ow can we definitely tell a tie from a relation?," formists cannot help but to contend that more data is needed, and formism thus leaves us with much 'vagueness,' 'vacillation,' and 'indefiniteness' (Pepper 1942: 185).

Inadequacies of mechanism

A basic difficulty in mechanism is the constant back and forth between 'discrete' and 'consolidated' interpretations of its root metaphor, which, according to Pepper (1942: 186), threatens to undermine the theory's coherence and integrity and thus seems to point to a fundamental inadequacy of the theory itself. In a nutshell, whereas forms of 'discrete mechanism' easily collapse into 'formism,' 'consolidated' versions tend to become as radical as to reduce most of their categories to one causal singularity and thus greatly lack explanatory scope.

The problem of categorical duality

The first and perhaps most central issue in mechanism is an outgrowth of the theory's inherent categorical duality – the conceptual differentiation between its 'primary' and 'secondary' categories (see Chapter 2: **Box 7**). Since these categories are defined in contrast to one another, they also depend on one another. Now, according to Pepper (1942: 194), the history of Western thought clearly shows that, notwithstanding, mechanism seems to incentivise its advocates to concentrate on either of the two categories. This obviously poses a constant threat to the overall scope of interpretation issued under the mechanistic banner – 'primary' and 'secondary' categories need each other to provide the scope required for a relatively adequate world theory (*ibid*.: 195). Pepper (*idem*) notes: "[i]t turns out, ultimately, our cognitive evidence for the structure and the details of the cosmic machine described through the primary qualities comes entirely from materials within the secondary qualities. The more detailed the development of the primary categories, the more obvious this fact becomes. And, on the other side, it turns out that the very conception of the secondary categories depends upon their contrast with the primary categories, so that any attempt to develop the former without the latter defeats itself, that is, implies what it denies."

In other words: because 'mechanists' seem to be inclined to reduce 'secondary' qualities to 'primary' qualities or the other way around, they tend to eliminate part of what their theory depends upon. Both 'physicalism' (or strong variants of 'materialism') and 'cognitivism' (or strong versions of 'idealism') are harbingers of this tendency. From the perspective of Pepper's world hypotheses theory, such colonisation of one set of categories with the other set can hence only be self-contradictory and clearly undercuts the cognitive adequacy of mechanism. Much of this problem is a consequence of the general difficulty to navigate the gap between *Appearance and Reality* proper to the 'integrative' world theories.

The problem of inevitability

The second problem is rooted in the assumption that the world is of a highly ordered and determinate nature. This issues the mechanistic tendency to believe in various versions of the *Laplacian demon*, that is, to assume that things that happen in the world can largely be said to have happened inevitably – in other words: to know all the relevant details of the world and all the relevant laws or regularities holding them together essentially means to know what *will* happen. Determinateness translates into inevitability and inevitably translates into the general predictability of events and phenomena. This conceptual inclination, however, generally conflicts with the motivation in 'mechanism' to cast the world into 'primary' and 'secondary' categories – namely to assert that the former are 'effective' while the latter are not (cf. Chapter 2: **Box 7**). In practice, this means that 'secondary' qualities often turn out to be accidentally rather than inevitable tied to or associated with 'primary' qualities and/or observable phenomena. This tension constantly threatens to destabilise the structural architecture of mechanism from within.

Moreover, the tension between what can be said to be 'accidental' and what can be said to be 'inevitable' can easily lead to mechanism dissolving into 'formism' for the independence of some qualities ('secondary' qualities) from laws and/or regulatory principles paves the way for the conception that laws are nothing more than basic forms which are repeatedly exemplified or instantiated in what is the spatiotemporal field – a conception that is proper to 'formism' (cf. Pepper 1942: 210). This is the trouble with mechanism: it cannot accept the essentially timeless and ever-continuing repetition of laws as exemplifications in space and time without falling into 'formistic' reasoning, but the rejection of this conception leaves no alternative as to accept that some things may not be inevitable – that there must be leeway for novelty and emergence.

According to Pepper (1942: 211), the only way to avoid the collapse of mechanism into a form of consolidated 'formism' is to "embed the primary qualities and the laws firmly in the spatiotemporal field" so that most of the residual discreteness is eliminated. Mechanism cannot accept discreteness since it is an 'integrative' theory; discreteness implies strict similarity and therefore 'formism.'[859] A 'discrete' mechanism would be self-contradictory (*idem*). To avoid conceptual discreteness, however, is extremely difficult to accomplish, especially with the categories that mechanism has at its disposal; mechanists need to distinguish between 'primary' qualities, 'secondary' qualities, laws, and the 'field of location' in order to relate them mechanistically and to provide an account of reality – these categories, in other words, are automatically rendered somewhat discrete in order to make them accessible and analysable. This is the ever-present doorway to 'formism.' From this difficulty it follows that mechanism has to be radical in explaining away the actual 'existence' of its own categories and to turn them into mere heuristic devices; ultimately, mechanism, in order to avoid existential discreteness, can therefore only accept the existence of space-time particulars (things are only real if they have a time and a place), a principle that can never be abandoned without self-undermination (*idem*).

In essence, mechanism hence faces major difficulties and self-made problems in accepting non-predictability, chaos, and chance and the statistical approximations of regularity is only acceptable as a convenient instrument to get a hand on the determinate nature of the world's field structure – a conception that cannot be abandoned without abandoning 'mechanism' itself. This almost inevitably leads to forms of existential minimalism: to uphold the internal consistency of its categorical structure, mechanism must defend the notion that only a single particular can exist and the search for this particular singularity must have research priority (cf. Pepper 1942: 214). This is why mechanism gravitates towards its 'consolidated' interpretation and tends to recast the world as an amalgamated field

[859] In order to identify entities as 'discrete,' they have to exhibit similarity to themselves and be different from other discrete entities.

structure – as a consolidated 'spatiotemporal-gravitational-electromagnetic field' (*idem*). Explanations which do not target this basic level of explanation are simply dismissed as irrelevant.

The issue of correlation

A practical weakness of mechanism and a major obstacle to its progression is the regular confusion of *correlation* and *causation*; to be effective and maximally adequate, mechanism cannot abandon this distinction because abandoning it would also bring down its constitutive categorical duality ('primary' vs. 'secondary' categories). In actual research, this problem is aggravated because what is given in observation is primarily 'secondary' qualities and the structure-giving entities of the spatiotemporal field remain unobservable; correlation is thus largely restricted to describe the relationships among 'secondary' qualities, relationships that may be 'ineffective' and 'accidental.' Correlation, therefore, cannot bridge the gap between 'primary' and 'secondary' categories and can never quite reach the basic level of explanation which mechanism aspires to reach. Yet, most of the time, mechanists have no choice but to use correlations to identify potential causal relationships, if only to narrow down the space of potentially relevant causal relationships. The threat of confusion is therefore omnipresent. Confusion might even serve as a tool of legitimation for correlations to serve as a proxy for causality and easily confirms the regular and well-ordered structure of reality.

This leads us to a more basic problem in mechanism which has already been alluded to but not spelled out yet: the impossibility to consolidate 'primary' and 'secondary' qualities without transitioning to 'formism' (Pepper 1942: 220, 230). This issue is linked to the problem of correlation for mechanists tend to note correlations between 'primary' and 'secondary' qualities in the hope to predict the latter from the former; this, again, threatens to undermine the constitutive and necessary complementarity between 'primary' and 'secondary' qualities (cf. *ibid.*: 218). As Pepper (*ibid.*: 231) adds, "the gap between the primary and secondary categories still remains the centre of inadequacy for mechanism." It indeed remains largely unclear how mechanism can reach out from the phenomenal world to the basic structure of the world without involving itself into basic contradictions. It is quite symptomatic that mechanists increasingly use methods of approximation to establish principles of determination but through such approximation they also never quite reach what they are looking for – their target of analysis (the most basic structure of reality) turns out to be fundamentally deprived from their analytical grip.

The mind-body problem

From the dual structure of categories another cardinal mechanistic problem emerges, an issue that has variously been described as the 'mind-body problem' (cf. Pepper 1942: 217, 220f.) and that is – not accidentally – tied to one of the great historical father figures of the theory: René Descartes. The mind-body problem is another consequence of the general difficulty in mechanism to bridge the gap created by its dual categorical structure.

The reconstruction of the problem may proceed as follows: since mechanists must accept the existential distinction between 'primary' and 'secondary' qualities but at the same time seek to establish that the latter are predictably correlated with the former, it seems unavoidable to conceive of 'secondary' qualities as some sort of *emergent* or *supervening qualities* – irreducible but nonetheless correlated features of the spatiotemporal field (cf. Pepper 1942: 221); to avoid giving way to 'formism,' mechanism further needs to ensure that its elementary units of matter are not just defined as 'immanent forms;' this in turn implies that the spatiotemporal machinery which mechanism seeks to understand is to be regarded as a highly structured field that never quite repeats itself in all of its details (*idem*). The same accounts for the 'secondary' qualities which even as emergent qualities can never quite repeat themselves in all of their details if one is to counter the persisting immanence of reality propagated by 'formism' as a world theory (*idem*). From this a conceptual dilemma emerges: if even the 'secondary' qualities will never repeat themselves in all of their details, they can also never be completely predicted and hence cannot really be said to correlate with the 'primary' categories (*ibid.*: 220).

But how can one then reach out to the primary categories in the first place? This short but rather abstract reconstruction of the mind-body problem should be sufficient to show that mechanism can hardly escape from it. Ultimately, the problem carries the seeds of mechanistic self-contradiction and poses a severe threat to impair the conceptual integrity of the theory.

Inadequacies of contextualism

The problem of arbitrariness and unconstrainedness

How facts are compared, selected and emphasised is a fairly unconstrained business in contextualism; it follows that evidential decision-making – that is, specification of which features of reality to include in the analysis, which to carry through the analysis, and which to neglect – appears to be as arbitrary as in no other theory (cf. Pepper 1942: 233f.). The theory typically circumvents this difficulty by its procedural logic – by asserting that analytical trial-and-error learning and time will tell which features to highlight and which to carry through the analysis. The problem is therefore mainly of a practical nature and pertains to the scholarly limitation of analytical resources including time; epistemic patience and endurance are qualities which must hence be invoked as preconditions of interpretive success in contextualism – a precondition which is difficult to ensure and sustain and often conflicts with the short-term interests of its practitioners.[860]

The problem of change

A main disadvantage of contextualism derives from its radical interpretation of change incorporated in its structural categories; the implication of this interpretation – placing natural emphasis on qualitative novelty and change – is that unchangeability (immutability) is denied as a structural feature of reality (cf. Pepper 1942: 234). This also entails the rejection of a unity of reality and all possible observations about it. Moreover, it generally undermines the ability of contextualists to compare disparate observations and findings – the radical and categorical heterogeneity of the world which is a consequence of the contextualistic categories hence threatens to undercut the capacity of contextualitsts to effectively communicate their findings and to defend their significance. But the openness for radical change has two further, perhaps more substantial, implications.

On the one hand, contextualism is "permanently threatened with evidences for permanent structures in the nature" (Pepper 1942: 235) and therefore easily develops sceptical attitudes towards the possibilities of effective synthesis and integration. It also has to fight all evidence of permanency and regularity presented by the 'integrative' theories. On the other hand, contextualism is potentially self-undermining because it, too, relies on conventional terms, methods, and concepts to advance its case and to make sense of its evidence; this means that, ultimately, certain generalities in meaning and significance have to be accepted in order to start any inquiry and to talk about evidence and interpretation, even if these are later dismissed in favour of others. Insofar as these methods, terms, and concepts cannot be unchangeable structures, they are always suspicious and constantly need to be revised. It is questionable how contextualists can escape this loop – the typical strategy is to accept it as a general condition of knowledge formation and to recast it positively. Contextualism is nonetheless generally threatened to impair its own ability to 'talk about' and define what it finds and thus to get lost in the ever-changeable quality and endless richness of the cosmic whole.

As a result of all of this, contextualism cannot hope to find strong legitimation in its own categories to transcend the historicity of its own findings; contextualism, in other words, cannot exclude itself from being situated and harbouring context-specific categories and concepts. This is a likely source of over-emphasising alterity and 'otherness' and thereby distorting similarity and 'sameness' in reality. It is an advantage insofar as contextualism, because of this inclination, is perhaps most eager

[860] It is important to note, however, that this weakness also implies that credible insights and knowledge in 'contextualism' are typically gathered on temporalities which differ from the other theories; 'contextualistic' inquiry subscribes to a long-term project of knowledge-formation which has no definite end.

among all the world theories to be self-critical and to highlight again and again its own epistemic limitations, and hence to develop source criticism and epistemological critique, often leading to anti-positivistic attitudes – what Pepper (1942: 252) characterises as its inability to exclude itself from its propositions, "to make an exception of oneself." It is a disadvantage insofar as reaching out to historical contexts other than one's own is always problematic, stained in uncertainty, and can never be based on safeguarded conceptual grounds; it always remains a working hypothesis at best. The categories and subcategories that contextualism develops are thus always threatened to be categories and subcategories mainly of our epoch, the epoch in which the investigator is living and working (*ibid.*: 236). Rival world theories identify this as the inability of contextualism to generate reliable knowledge claims about other historical or cultural contexts beyond the reassurance of the radical difference of these contexts – this is partly ironic, since contextualism is the one world theory which takes change and novelty most serious, but cannot do so without serious repercussions as we have seen.

The problem of demandingness

From what has been said so far, it follows that contextualism generally confronts its practitioners with a difficult analytical task and cannot provide them with generalisable or invariable guidelines for analysis; analysis in contextualism is therefore extremely demanding and plastic – clearly, it is nothing that can be standardised to a high degree. Again, the issue, then, is mainly practical in nature since it follows that to practice contextualism in a satisfactory manner is meticulously difficult and will probably produce many false negatives or loose ends despite of it being proficiently executed. Contextualism's weakness is its adherence to the dogma of 'nothing can be presumed other than nothing is presumable.' This not only makes it difficult to reject anything – contextualism is the most 'liberal' theory in this regard (cf. Pepper 1942: 235) – it also affects the clarify and integrity of the theory itself. For the credo that 'nothing can be presumed other than nothing is presumable' strikes a dubious balance between being tautological and being logically inconsistent. Ultimately, contextualism may ask too much from scholars to develop its full potential and therefore often drifts away from its conceptual core resulting in eclecticisms with the other world theories.

The problem of un-completeness

By the particular way in which contextualism rejects the dogma of complete 'analyticity' and recasts element analysis as intrinsically distorting (Pepper 1942: 248), it also introduces the assumption that no final or complete analysis of anything is achievable (*ibid.*: 249). Contextualistic analysis cannot escape what Pepper (*idem*) calls the "sheering effect," that is, the somewhat arbitrary ingression and categorical openness of analysis and reasoning. In fact, the more one contextually digs into reality – into its quality and texture – the more one has to revise what one has to be taken for granted in the beginning (*ibid.*: 249f.). This ongoing revision of findings and certainties will never stop and continue *ad infinitum*; contextualists cannot escape this ever-growing stream of novelty and analysis and knowledge thus appear to be "bottomless" (*ibid.*: 250). There is no clear beginning and no clear end of the interpretive journey. The only way out seems to be to admit that both entry and end points of analysis are more or less contingent or to conventionalise them – but this, too, remains arbitrary. In total, knowledge and analysis remains always unfinished in contextualism and this inherently problematises the status of knowledge claims therein. A general weakness of 'dispersive' theories joins forces with this unfinishability: there are many and equally revealing but nevertheless non-comparable ways of finding contextual meaning in evidence (*idem*). Combined, this issues the threat of conducting analysis for analysis sake (*idem*).

The problem of uncertainty

The problem of uncertainty is an amalgamation of all the three problems discussed before. The inherent uncertainty of knowledge that contextualism seems to imply leads to a general difficulty to clearly distinguish between what is positively analysable in the world (that is, whether and to what degree references are traceable, if only into past and future contexts) and what is not ('blocked' strands and references), and whether this is primarily the result of processes operating in the world or has more to do with the inability of researchers to find meaningful references and relations – a condition that may be defined as "cognitive blocking" (Pepper 1942: 279; see Chapter 2: **Box 8**). In general, this makes it very difficult to distinguish between interpretive significance and irrelevance in contextualism. The issue is serious and typically engenders endless and often circular debates about evidential and argumentative details and potential biases both in the available data and in scholarly cognition. Again, the structural category of novelty undermines any certainty claims that are able to transcend the here and now. There is a threat here that contextualism confuses itself.

The issue of elasticity

In a sense comparable to 'formism,' contextualism faces the serious threat that its operational categories are clarified by other theories and thus overcome by the competing conceptions of truth that these theories harbour (Pepper 1942: 278f.). The contextualist can do nothing on her/his own to prevent this clarification from happening and may thus only admit: "catch me if you can!" (*ibid.*: 279).

Contextualism's perhaps greatest strength is at the same time one of its main weaknesses: its basic pragmatism and extreme *interpretive elasticity*. The key issue here is the difficulty of extrapolating insights from one context to another, or even using insights from one context to intuit or pre-organise the evidence from another context and to formulate some general expectations – this procedure, as we have seen, is greatly hampered by contextualism's insistence on novelty, change, and context-specificity. The implication is that contextualism tends to accept only the primary and context-specific corroboration of knowledge claims, what Pepper (1949: 279) terms 'direct verification', and is generally extreme sceptic when indirect, context-detached or context-transcendent lines of evidence and argumentation are utilised. According to Pepper (*idem*), this leads to the following dilemma to characterise the situation of contextualism:

> "[e]ither you must confine yourself to believing only in the facts of direct verification, in which case your theory lacks scope; or if you admit the validity of indirect verification, you must admit that nature has a determinate structure and so fall into the contradiction of both affirming and denying this structure of nature."

The only escape is to insist on the possibility that even those features of nature which seem to be context-transgressing at first glance, might turn out to be bound by some larger context, perhaps of time itself.

The contextualist, in other words, has to extend his notion of contextual framing from localised contexts to larger-scale contexts such as 'domains' or 'realms' of reality and to assert the specifity of categories, concepts, behaviours within these divisions; she/he will then typically contend that time itself delineates different context and we cannot know that the generalities we observe now will remain generalities if we extend our temporal scope – she/he will ask how one can know that generalities in the here and now will not change in the course of time and so turn out to be context-specific after all. It should be obvious, however, that contextualism can never provide evidence for why this must necessarily be the case.

Even though contextualistic knowledge is typically very rich, it tends to remain insular. This insularity, rooted in the elasticity of contextualism's structural categories, turns out to be its cardinal weakness. It cannot stop to posit "the ultimacy of blocking, novelty, fusion, and so forth [...] only in the end to find that his greatest difficulty arose in his [the contextualist's] inability, without retreating, to specify the structural features of nature" (Pepper 1942: 303f.). At some point, contextualism, too, has "to admit integrative structures surrounding and extending through given events though these structures endanger its categories" (*ibid.*: 281). This is the source of the constant danger of self-contradiction that haunts contextualism as a world theory, carrying the fruits of serious cognitive inadequacy.

Lastly, we should recall that the perhaps most difficult task for relativists in general – and contextualism clearly trends towards relativistic conceptions of reality – remains to explain why the claim that everything is context-specific or relative to a context does not include the very statement of context-specificity itself, which then, too, turns out to be context-specific and not generally valid. Hence, there remains little ground for accepting radical novelty on worldwide scale without falling prey to this fallacy. Contextualism is always threatened to undercut itself in this regard.

Inadequacies of organicism

The polarity between 'progressive' and 'ideal' categories

The main source of cognitive inadequacy in organicism can be found in the categorical polarity between its 'progressive' and 'ideal' categories (Pepper 1942: 281f.; see Chapter 2: **Box 9**); just like in 'mechanism,' this polarity gives rise to an inherent conceptual dualism provoking categorical friction and implying tendencies of self-contradiction. The polarity sits at the heart of the specific organicistic problem of transition from the 'progressive' and 'ideal' categories which is structurally similar to the transition from 'primary' to 'secondary' qualities found in 'mechanism.' As mentioned before, we are facing a general difficulty of 'integrative' theories here, a difficulty that derives from their attempt to navigate and ultimately resolve the conceptual distinction between *Appearance and Reality* on which they are based. That such attempts can only be self-undermining should have become evident.

Organicists find it generally tempting to reduce reality to its ideal categories and often proclaim that only those categories truly "exist" (Pepper 1942: 282). This essentially means the reality of appearances which are identified with the 'progressive' categories and may distort what is structurally given. A full reduction of the 'progressive' categories to the 'ideal' ones is nothing else than denying one's own categorical preconditions which is potentially self-contradictory and at least greatly restricts the scope of the theory. 'Progressive' and 'ideal' categories are co-dependent and over-emphasising or denying one of the two poles does only harm to the integrity, consistency, and clarity of the theory. If the 'ideal' categories, on the other hand, are omitted, organicism runs the risk of becoming a refined version of 'contextualism' where temporal integration is simply re-interpreted in the light of the root metaphor 'historical event'/'situationality' (*idem*). Hence, the conceptual symmetry between 'progressive' and 'ideal' categories must not be abandoned but the drive for integration and consolidation in organicism often motivates scholars to do so.

The problem can also be recast as a problem of transition. What one observes and what is given in experience is mostly if not exclusively the 'progressive' categories – the appearances of reality; the question is therefore always how one can safely bridge these appearances or make them usable to reach out for the 'ideal' reality. Independently of how one solves this issue, much depends on the nature and structure of appearances and they must therefore always retain their analytical value (Pepper 1942: 283). To discredit them, render them epiphenomena, or to explain them away entirely makes the theory somewhat unbalanced, internally incomplete, and suspicious to say the least. The tendency of the 'ideal' categories to monopolise reality, in other words, poses a constant threat to the conceptual integrity and consistency of the theory.

The problem of never-ending integration

The second issue arises out of the interpretive focus on integration which is at the core of organicism. How integration can be reached and is used in organicistic inquiry, however, suggests an *infinite regress*, an unbreakable loop of integration, disintegration, and re-integration. The reason is that organicistic integration is typically reached in levels and each integration of parts (i.e., fragments of reality) produces wholes which can be turned into new fragments because they are surrounded by other wholes and therefore confirm a new level of conflict; there is no reason to believe that this logic can ever be broken (Pepper 1942: 298f.). In fact, the entire point of the 'ideal' categories is that they are 'ideal' and may therefore *never* be reached, achieved, or accomplished. This practically means that organicism can never be complete and always remains an approximation of the 'ideal' categories it seeks to map. Comparable to 'contextualism,' organicism is therefore also threatened to indulge into integrative analysis for analysis' sake; it provides an epistemic drug which motivates scholars to dig ever deeper into the structure of reality only to discover that the structure is likely 'bottomless' and extremely complex. Another way of saying this is to confess that the objective of integration turns out to be an 'ideal' category itself.

The issue of illusionary contradictoriness

Another paradox is suspicious in organicism: the relationship between conflict and integration. Contradictoriness turns out to be a categorical precondition of integrability in organicism. This is why conflict mast be assumed to be a general feature of reality; to secure the integrability of reality, conflict is exiled to the realm of appearances and is thus found to be a characteristic mainly of the 'progressive' categories. This is why organicists need to be 'generally dogmatic about the inherent contradictoriness of all experience short of the absolute" (Pepper 1942: 302f.). This situations has two consequences: it may (i) greatly distort harmony and structure in appearance, and (ii) show that the structural categories of organicism are fallible themselves.

The first consequence can be reconstructed as follows: it is only out of the contradictoriness of all fragments, which therefore turn out to be partial facts, that the organicist can find evidence for the coherence of all absolute facts (integrated organic wholes) – it follows that there can be no partial fact which really stands for itself and this is a source of great potential distortion since all the fragments of reality are consequently deprecated and not taken seriously (cf. Pepper 1942: 302). In pair with the fact that the 'ideal' or 'absolute' almost always escapes our analytical grip, we are always left with some degree of partiality and we may suspect that this is precisely where organicism has to confess its own incompleteness. In addition, organicism is generally vulnerable to all evidence that shows strong coherence among fragments for this threatens to undermine the category of conflict. Yet, because of the crucial role of time in organicism, it remains unclear how much coherence in appearance is enough to dissolve the theory – this in itself might be considered a weakness.

The second consequence is perhaps best exemplified by the general argumentative strategy of organicistic inquiry. Organicists first tend to show that conflict applies to appearances and that the fragments of reality therefore turn out to be isolated and fragmentary, only to show thereafter that this fragmentariness turns out to be illusionary and can in fact be transcended if one only finds the correct organic whole to resolve the fragments (cf. Pepper 1942: 304f.). This appears to be suspiciously self-undermining since the organicistic strategy to find order in reality appears to consist in disproving or at least temporally rejecting its own categories (only to later re-introduce them again) – this again opens the door for denying the existence of 'progressive' categories and may result in further self-restraint. The trouble is to assert conflict in reality only to then claim that the conflict turns out to be illusionary. We may ask why, then, has conflict to be presupposed in the first place? The answer is that 'conflict' primarily has a methodological status – but this is difficult to uphold given that the structural architecture of organicism and organicistic interpretations of 'conflict' too often involve ontological claims.

The tension between integration and object-specificity

Another important tension endangering the internal consistency of organicism results from the tendency to emphasise the specificity of pathways that lead to the integration of wholes in duration and the organicistic aspiration to remove all residual conflict through integration. Object- and phenomenon-specific behaviours and developments threaten to undermine such integrability and the heterogeneity of reality – an important practical assertion of organicism – turns in this way out to be illusionary as well. This is clearly problematic and reveals that organicism has difficulties to consistently embrace the determinate structure of reality it presupposes.

The issue of analytical complexity, challenge, and interminability

As a 'synthetic' theory, organicism faces a similar problem as 'contextualism' in dealing with the open-endedness of analysis, an interminability it ultimately has to self-admit (Pepper 1942: 308). This open-endedness is for instance implied in the organicistic conception of truth which culminates in the claim that truth itself is nothing else than an ever evolving cognitive capacity to integrate. The basic issue here is whether organicism ultimately has to confess that humans, human cognition, and human life are only incomplete appearances themselves, that they remain fragmented and are too much stained in bias and ignorance as to effectively reach out to the 'ideal' or 'absolute' (which would be 'more-than-human'). We can ask, in other words, whether organicism simply demands too much of human cognition and whether human life cycles are too short to give justice to the need to integrate partial facts over time in order to grasp the coherency that emerges from them. Organicism thus renders the temporality of scholarly inquiry as problematic as no other theory and thereby issues a certain scepticism about its own success. The theory has to confess that it is extremely challenging and difficult to master in this regard; it consequently affords extreme analytical complexity (in particular when it comes to the interpretation of 'time') – a complexity that can easily result in epistemic aberrancy.

The issue of time and truth

Time and truth are intimately connected in organicism. This has many advantages but also provokes some difficulties. The first is that the temporalisation of truth inevitably results in truth coming in degrees (Pepper 1942: 310f.). This not only makes it difficult to directly compare individual knowledge claims but is also largely at odds with the general organicistic intuition that the world is of a determinate order. The second difficulty has to do with the role of time itself. Time is both a precondition and a barrier to organicistic knowledge (*ibid.*: 281).

This paradox paves the ground for conceptual friction and likely indicates some general inadequacies of the theory. To begin with, time is recast as something that is needed for integration; time is what organises fragmentation and what ultimately explains why reality persists through 'conflict;' but this also means that it is because of our temporal existence that we can only see conflict where there is order to be expected. This has two further implications: first, time cannot be 'real,' it must be an appearance and therefore belong to the 'progressive' categories; second, 'ideal' facts must be timeless and immutable, they must ultimately be eternal (*ibid.*: 313). This leads to the paradoxical situation that a temporal perspective is required to identify relevant facts, nexuses, and trajectories of integration as well as to find truth and order in conflict, but time concurrently needs to be explained away to secure the aspired order; organicism tends to take time seriously and "disparagingly" at the same time (*ibid.*: 280f.).

Having said this, already the tendency to explain away time should be suspicious for the importance of time seems to be such a strong common-sense experience and there appears to be a lot of evidence for its significance. Explaining away time therefore seems to be a high price to pay – it unmasks a lack of scope since the price of including all relevant facts is to exclude the fact of time (*ibid.*: 314).

II.3 **Two ideal-typical perceptions of the worldly affairs**

Hans-Peter Hahn (2013: 33-37, Abbildung 1.3) has recently distinguished between two modes of predicating the world, both prominently advocated in anthropological theory: (a) the 'layer-cake model' [*Schichttortenmodell*]; and (b) the 'pound-cake model' [*Rührkuchenmodell*] (**Fig. II.1**). According to Hahn, the former presupposes a 'bottom-up'-structured and well-organised world where different domains of reality determine each other in a directed and largely pre-ordained manner (cf. *ibid.*: 34); the resulting 'layers' even provide *normative* orientation for the lower segments which are supposed to be 'easier' to reconstruct. The latter, by contrast, assumes a 'messy' and complicated world where different domains of reality merge and tangle into each other, so that the boundaries of some (or all) domains begin to disintegrate (cf. *ibid.* 34f.); the resulting 'mixture' of reality suggests a co-dependency of all domains – culminating in the view that each domain *implicates* all other domains. While the 'layer-cake-model' is consistent with the regulative idea of the *Homo oeconomicus*, the 'pound-cake model' supports the regulative idea of *l'homme total*.

These two ideal-typical models of the basic structure of the world can be taken to illustrate two of Pepper's world theories and their differences: the 'layer-cake model' [*Schichttortenmodell*] clearly epitomises how 'mechanism' typically conceptualises worldly affairs, whereas the 'pound-cake model' [*Rührkuchenmodell*] can be taken to reflect how 'contextualism' tends to precast the nature of reality.

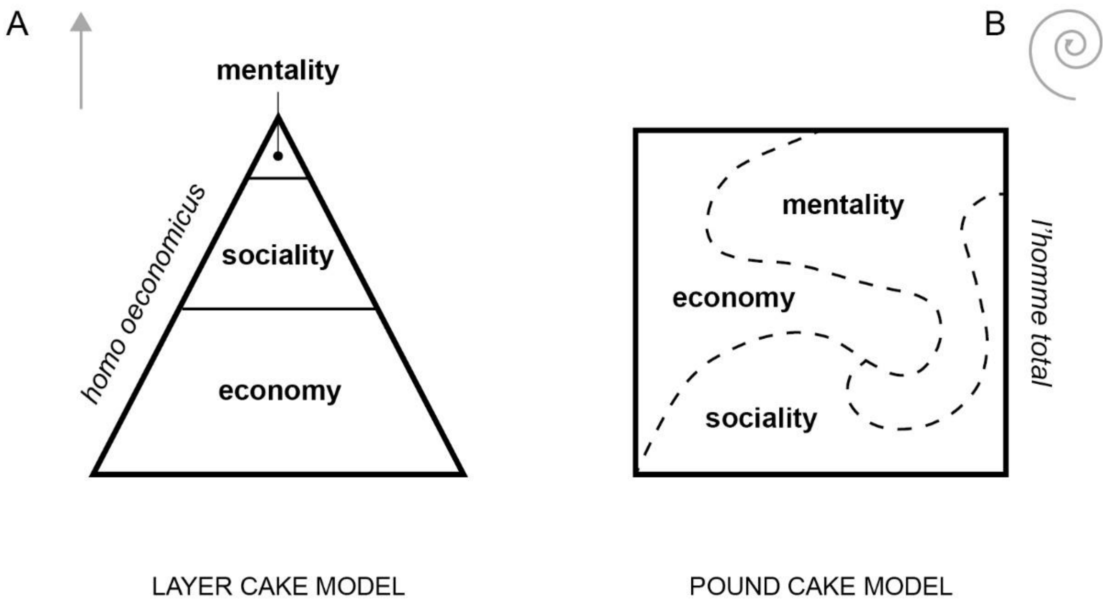


Fig. II.1 **Two contraposed models of worldly affairs: [A] 'layer-cake' model (*Schichttortenmodell*); [B] 'pound-cake' model (*Rührkuchenmodell*). Small grey arrows in the left and right top corner indicate dominant vector of inference (based on Hahn 2013).**

Appendix III

Supplementary information on Chapter 3, 4, and 5

III.1 **Schemes of reasoning and inference-making**

The diagrammatic representation of pathways and structures of reasoning helps to visualise how scholars precede from their data to their conclusions. The resulting graphical outputs specify when and how arguments are made, how data is handled, which data-processing procedures are used and what the general strategy of sense-making is. These outputs are what I call 'schemes of reasoning and inference-making' – graphical outputs that generally place emphasis on the inter-link between the various elements of reasoning. The main advantage of using them is to 'objectify' how evidence is treated and made sense of and to thereby make it transparent and easily accessible; this, in turn, enables smooth structural comparison between varying lithic approaches. The method I have used is simple but effective and – to my knowledge – has never been applied to the practice of Palaeolithic archaeology before.

Methodological procedure

The methodological procedure is as simple as it is challenging:

- The <u>first step</u> is close and critical reading of the research output (paper or monograph) in question. Part of this is the specification of analytical boundaries – that is, the determination of the target of analysis. In monographs, for instance, one may only be interested in exposing the logic and structure of reasoning with regards to a specific object of study – for example with regards to a single lithic assemblage even though the monograph analyses multiple assemblages.
- The <u>second step</u> is to identify, simplify and arrange the main analytical steps and to list them in chronological order. This involves a preliminary determination of their role and their status (e.g. as main arguments, sub-arguments, supporting arguments, and so forth). Here, the hierarchy of the identified elements of reasoning is already a critical feature to address.
- The <u>third step</u> is to note conclusions and sub-conclusions that emerge at various juncture points of the analysis. This is also the moment to note a simplified version of the global research conclusion (if necessary in levels of interpretive progression, abstraction, and/or generalisation).
- The <u>fourth step</u> is to check for the overall consistency of the noted steps with regard to the conclusions and sub-conclusions and to ensure that the latter logically and/or argumentatively follow from the identified analytical steps and their progression. The result is the identification of the overarching logic and structure of reasoning. Everything that does not directly follow from what has been noted already and that is crucial for this logic and structure is noted separately. If consistency and transparency of the structure of reasoning with regard to the role and status of each element could not be reached, one must return to the first step and reiterate the procedure until clarity has been gained.
- The <u>fifth step</u> consists of graphically outlining/drawing the identified global structure of reasoning. The representational focus should thereby lie on the interdependency (and independency/synchronicity) of various 'lines of reasoning' and their chronological unfolding – in other words: on the horizontal (distinct but equally important pathways of reasoning) and vertical (chronological order of pathways of reasoning) structure of reasoning. A number of conventions are to be followed in order to do so; these are described below. It is to be stressed, however, that additional conventions and symbols may be introduced at any point as long as they are equally applied to all of the analysed cases.

Graphic conventions and employed symbology

Boxes: boxes signify distinct segments or elements of reasoning and determine what elements are to be connected in order to arrive at the final conclusion.

Arrows: arrows connect various boxes and indicate the direction of the connection as well as the importance of the connection (regular lines show more important connections than doted lines which indicate structural relationships).

Colours: elements of reasoning which are primarily internal to the analysis are displayed in grey or black dependent on their importance (progressive elements are usually shown in grey, whereas conclusions and sub-conclusions are shown in black); boxes with grey filling designate elements of reasoning which refer to other relevant findings in the same study based on other data (e.g. comparative data not identical with the data used in the analysis under consideration); elements of reasoning which are largely external to the analysis of data are shown in orange (e.g. general high-level theory mobilised prior to analysis, generalisation made before and or after the analysis and that do not follow necessarily from the available evidence, supporting arguments which are imported from the outside); green is generally used to designate a positive analytical finding (e.g. positive correlation, statistical test revealing significant differences, etc.); red is generally used to mark negative analytical findings (e.g. failed identification of statistical differences, argument of rebuttal, etc.).

Circles with a plus/minus: circles signify the execution of a statistical and/or quantitative procedure; the nature of the procedure is specified by adding a textual description to the circle (if not specified further, circles stand for simple quantitative statistics); the size of the circle indicates how significant the findings are; the colour specifies whether or not the procedure yielded a positive or negative results (see *supra*).

Supplementary graphic outputs

Results of analysing the scheme of reasoning and inference-making that are not provided in the main text are presented in **Figures III.1**, **III.2**, and **III.3**.

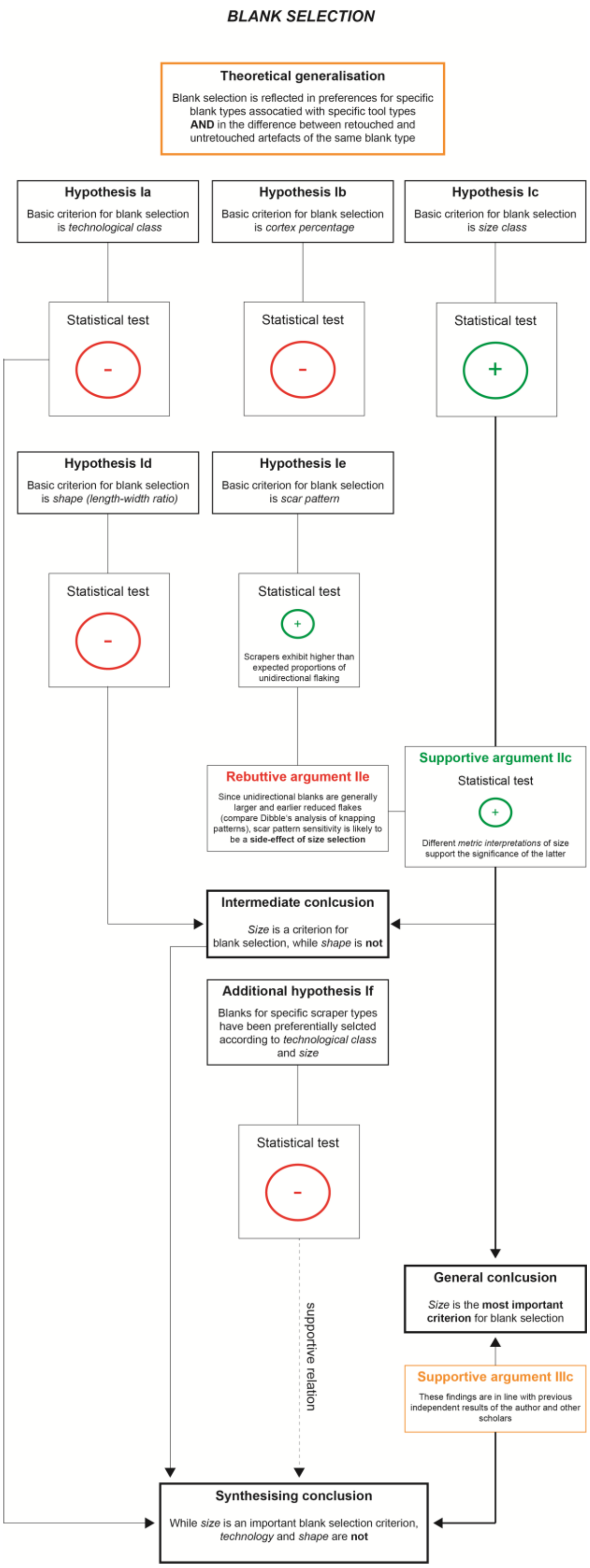


Fig. III.1 **Structure of inference underlying Dibble's (1995a) reconstruction of patterns of blank selection at Biache Saint-Vaast IIA.**

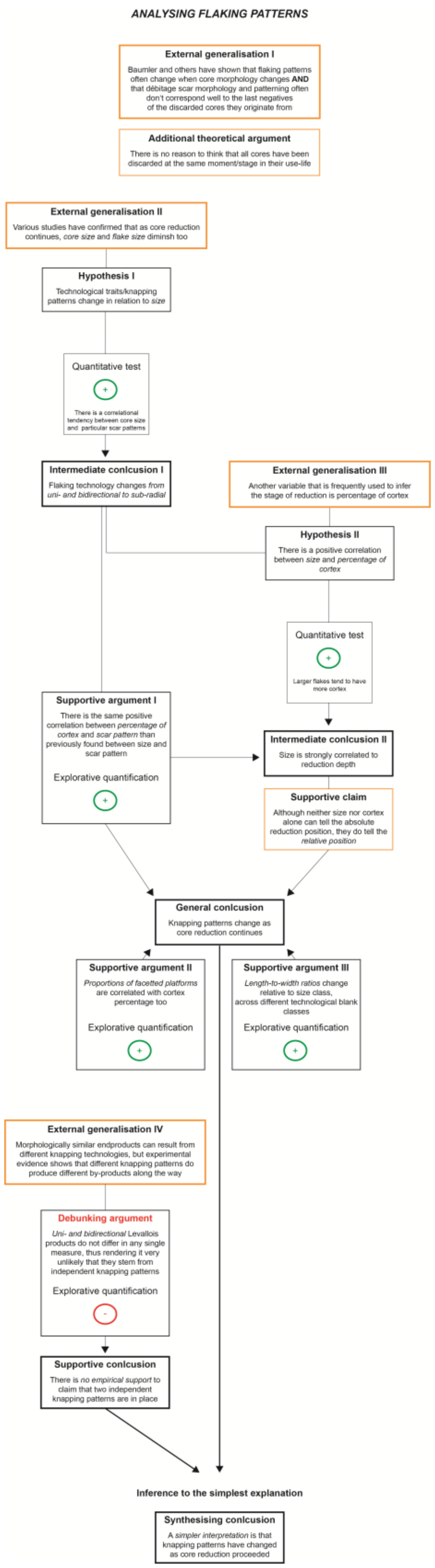


Fig. III.2 **Structure of inference underlying Dibble's (1995a) reconstruction of flaking patterns at Biache Saint-Vaast IIA.**

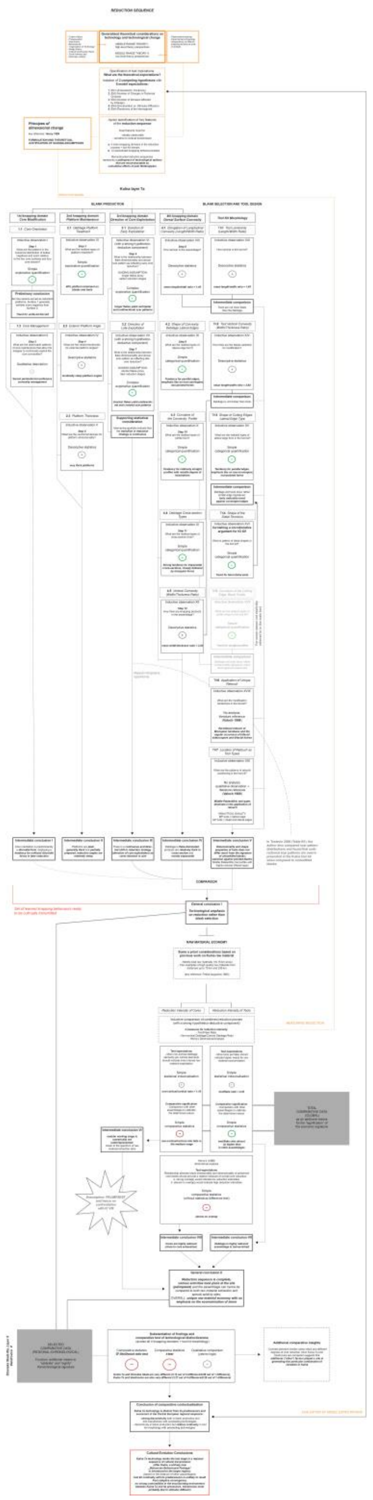


Fig. III.3 **Structure of inference underlying Tostevin's (2012) reconstruction of technological organisation and its significance in Kulna 7a. Note that only the interaction between the general theoretical framing of the study and the specifics of making sense of the Kulna evidence are displayed.**

III. 2 **Generalisation of data handling and modes of 'cognitive digestion'**

The following figure is an attempt to graphically synthesise what has been found in Chapter 3, partly based on the delineation and comparison of schemes of reasoning and inference-making. **Figure III.4** captures the key elements and the general architecture which has been found to typify scientific reasoning in French and Anglophone lithic analysis respectively.

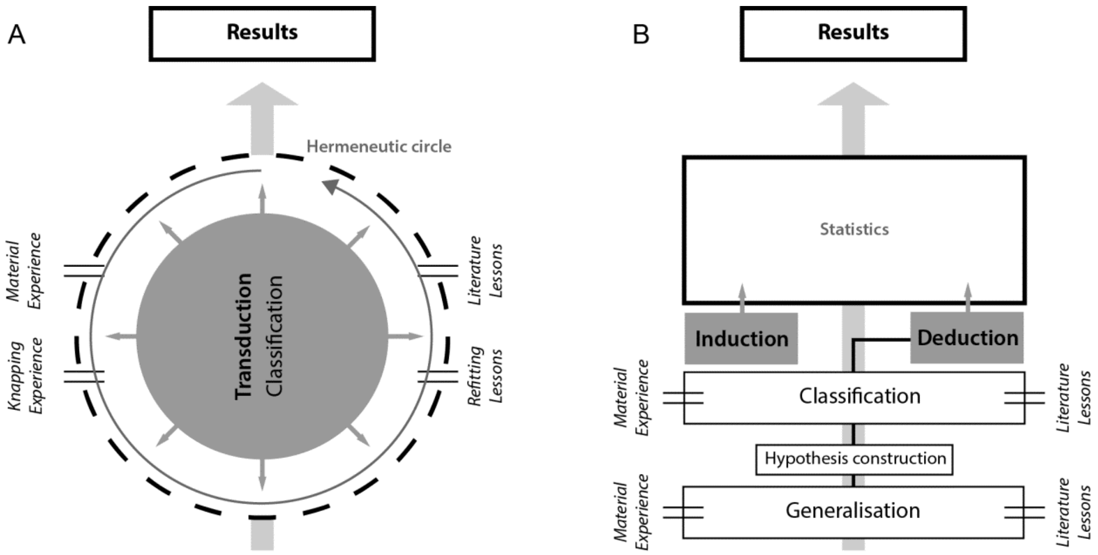


Fig. III.4 **Schematic comparison of the cardinal directionalities of inference and the relative openness/enclosedness of reasoning in French (A) and Anglophone (B) lithic analysis. The former conforms to a 'synthetic' treatment of data, whereas the latter conforms to a strictly 'analytic' treatment of data.**

III.3 **Vaesen and Houkes' (2017) definitions of complexity**

In a recent survey on persistent definitions of complexity in the literature on technological evolution, Vaesen and Houkes (2017) have identified nine understandings of the concepts. Each of the definitions implies different 'adequacy criteria' for testing what the author term 'complexity thesis,' the idea that there is a cumulative trend in technological evolution. The list of criteria and definitions they provide has heuristic value also independently of the 'complexity thesis.' Their summary table is therefore reproduced here. The nine definitions are used as a reference and are compared with the dominant French and Anglophone notions of complexity in order to retrace which part(s) of the spectrum of possible definitions is covered by both research spheres. We should keep in mind, though, that Vaesen and Houkes' list has been designed for the 'theory-hypothesis-test' mode of science and their explications may therefore lean towards an 'analytic' understanding of complexity.

Table 1 Definitions of technological complexity

Nr.	Definition of technological complexity	Applies to	References
[1]	Complexity expressed as the number of techno-units an artifact consists of; techno-units are the different kinds of parts in a tool	Artifacts	Oswalt (1973, 1976)
[2]	Complexity expressed as the number of tools in a toolkit	Artifact sets	Oswalt (1973, 1976)
[3]	Complexity expressed as transmission inaccuracy, i.e., the inaccuracy of learning a trait from a mentor; complex skills are those that are hard to learn, and thus have high transmission inaccuracy	Behavior	Henrich (2004) and Powell et al. (2009)
[4]	Complexity expressed as skillfulness	Behavior	Mesoudi (2011b)
[5]	Complexity expressed as the presence of multiple sets of (inexact) means-end connections	Behavior	March and Simon (1958)
[6]	Complexity expressed as the presence of interrelated, conflicting subtasks	Behavior	Campbell (1984)
[7]	Complexity expressed by the density of interactions between a system's parts	Undefined; can be applied to artifacts and behavior	Simon (1962)
[8]	Complexity expressed as a function of the number of parts, the degree of differentiation or specialization of these parts, and their integration	Undefined; can be applied to artifacts and behavior	Service (1962)
[9]	Kolmogorov complexity of an object (e.g., a use plan) expressed as the length of the shortest description of that object	Undefined; can be applied to artifacts and behavior	Kolmogorov (1974)

Tab. III.1 **List of definitions of technological complexity provided by Vaesen and Houkes (2017: Table 1).**

In an earlier version of their paper, the authors listed a total of ten different conceptions of complexity. The missing definition [10] is what Richerson and Boyd (2005) have termed 'adaptive complexity.' Adaptive complexity refers to the degree to which a system is adapted to its environment. Similarly as definitions nr. [8] and [9], this definition can be applied to both artefacts and behaviour.

III.4 **On the selection of case studies to delineate the four world theories in lithic analysis**

The list of chosen case studies and discursive fields to illustrate persistent 'tropes' of the four world theories in French and Anglophone lithic research is necessarily selective and incomplete. The purpose of the case studies is to demonstrate – although they of course cannot do so comprehensively – that Pepper's world hypotheses theory furnishes conceptual categories which greatly facilitate an understanding of the various cognitive strategies underlying actual lithic research and that these are largely different if we compare the two research formations. Their purpose is to exemplify, metaphorically speaking, that the Pepperian 'cake' constructed in Chapter 2 can in fact be 'eaten' and that it 'tastes well' and produces only little 'leftovers.'

The selection of case studies was guided by the following rationale: the cases should be as representative as possible with regards to how a research paper or monograph typically looks like in the respective research context; they should, if possible, represent classic findings (e.g., in Anglophone research that ecological conditions play a key role in shaping lithic technologies) and discussions; they should refer to relatively recent publications although some classic studies (e.g., Boëda 1988; Henry 1995) have been included to demonstrate the historical continuity of cognitive strategies. The aim of case study selection was to render the nature and number of cases on each side and in each category as comparable as possible (e.g., a comparable structure of case studies for the 'integrative' theories and for the 'dispersive' theories).

Some further clarifications are in order here. The Anglophone cases illustrating 'formism' (Chapter 4, first part) reflect the following premises and analytical decisions: first, I wanted to showcase the proclivity to concentrate on shape and physical form, and the current trend to do so with high resolution data and as much quantitative information as possible; secondly, I have selected demography, cognition and social/cultural transmission as representatives for typical 'subsistent' categories; thirdly, I have tried to depict the recent trend to return to phylogenetic reasoning and to apply multivariate (attribute- and/or trait-based) methods (this includes 'data-first' approaches with a trend towards 'big data'); fourth, my selection hopes to reflect the importance of 'classification,' the influence of phenotype-oriented evolutionary theory (including cultural transmission theory), as well as the impact of the archaeologies of David Clarke and Desmond Clark (*Analytical Archaeology*, *World Archaeology*, *Economic Archaeology*, *Geographic Archaeology*) and of British *Cognitive Archaeology* on this type of lithic research.

The Anglophone cases illustrating 'mechanism' (Chapter 4, second part) have been selected based on the following considerations: first, reduction theories and the notion of the 'reduction sequence' are showcased as a key area of theorisation and investigation; secondly, *Ecological Archaeology* and *Behavioural Ecology* have been selected as highly influential candidates to analyse lithic technology in light of functionality, mobility, and the environment (including prey- and habitat-selection); third, the environment is depicted as a core area of inquiry and I am convinced that strong variants of history-poor 'adaptationism' and 'selectionism' characterise the 'mechanistic' reading of evolutionary and ecological theory with regards to lithics; fourth, I wanted to highlight the role of the *New Archaeology* in the wake of Lewis Binford and others and of *Paleoanthropology* in the wake of Clark F. Howell and Desmond J. Clark as central research backgrounds (modelling scientificity mainly on physics and the life sciences).

The selected French cases illustrating 'contextualism' (Chapter 5, first part) group three main strands of research together: the 'late' Leroi-Gourhan's *« Palethnologie »* (or *« Ethnologie préhistoire »*), the classical 'technological approach' relying on *chaîne opératoire* methodology in the wake of Jacques Tixier and his students (also known as *« Technologie préhistoire »*), and the 'techno-economic approach' to lithic technology with an emphasis on mobility and the organisation of raw material use inspired by the work of Catherine Perlès, Jean-Michel Geneste, and others. Furthermore, the selection of the case studies aims to clarify some frequently held misconceptions, including the status and role of 'types' and 'typology' in lithic research; mobility and economy are discussed in conjunction with the techno-economic paradigm in order to contrast the treatment of these topics with the findings of Chapter 4; in addition, I use some of the emerging strands of inquiry tied to the work of the Toulouse group (cf. e.g., Renard and Ducasse 2015), which I consider a new potential institutional player alongside Paris and Bordeaux; and I, lastly, present the French understanding of 'mental refitting' for easy contrast with Anglophone interpretations.

The French cases that have been chosen to represent 'organicism' (Chapter 5, second part) represent more recent trends in the French scene; they mainly group together newer approaches that target long-term developments (*longue durée*), the main branches of which can be tied to *« Paléohistoire »* (Nicole Pigeot, Boris Valentin, François Bon, Grégor Marchand) and the 'techno-genetic approach' (Éric Boëda). In this context, I have chosen to thematise time as a central concept and the idea that technology evolves 'organically,' bringing into focus French philosophy of technology and Bergsonian understandings of evolution which contrast with the dominant interpretations of evolution in Anglophone research; in order to counterbalance the somewhat abstract character of these new research trajectories, I have selected Éric Boëda's classic study of Levallois recurrent as a potential early case of 'organicistic' assemblage-level analysis, even though this status remains somewhat debatable.

It goes without saying that a broad historical and conceptual survey of the wider landscape of approaches in French and Anglophone Palaeolithic archaeology is a prerequisite for this logic of case study selection. Such a survey was conducted prior to analysis but cannot be discussed here in detail (but see **Fig. III.5** for an overview). It must suffice to say that I tried to be as sensitive as possible for the most recent trends within each research context and to take into account the relative importance of different authors in shaping or representing these research contexts. Each of these decisions is of course debatable, but such a debate must always be specific about what is considered to be 'at the centre' of each research formation. My approach takes an explicit stance in this regard.

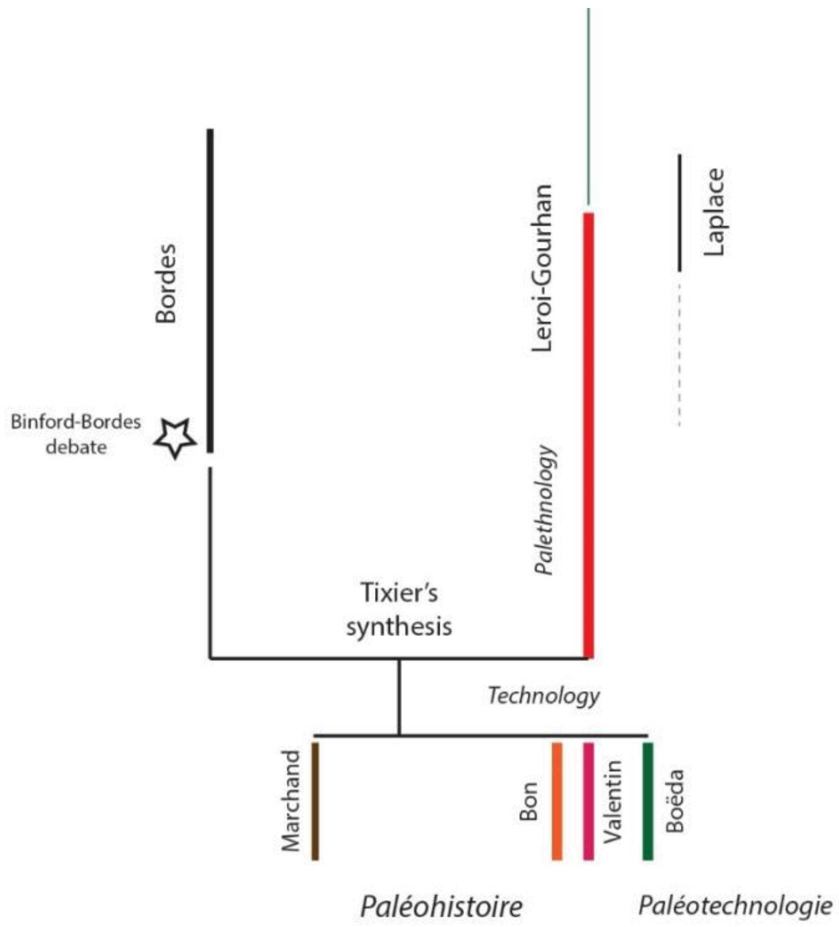


Fig. III.5 **Schematic overview of the historical trajectory of French « *Préhistoire* ». Modern palaeo-archaeological research starts with the three great figures of the post-war era: François Bordes, André Leroi-Gourhan, and Georges Laplace. Bordes develops the stratigraphic method, lithic typology, and cultivates knapping experimentation; the 'Late' Leroi-Gourhan develops « *Palethnologie* ». The former establishes the French geo-archaeological heritage, while the latter plants the seeds for a distinct socio-anthropological legacy (Leroi-Gourhan's line can be retraced directly to Marcel Mauss). However, it is only with Jacques Tixier, through a synthesis of Leroi-Gourhan's *chaîne opératoire* and « *Palethnologie* » with a Bordian understanding of technicity and lithic knapping, that the modern field of 'technological research' is created. After the consolidation of this approach in the late 1990s and early 2000s (integration of « *Ethnologie préhistoire* » and « *Technologie préhistoire* »), French palaeo-archaeological research diversifies again into several potent sub-strands, all of which share a certain preoccupation with long-term and diachronic developments; they subscribe to what can be called « *Paléohistoire* » *sensu lato*. Three to four sub-strands can be identified: « *Paléohistoire* » *sensu stricto* represented by Boris Valentin (focal point: societies) and Grégor Marchand (focal point: human-environment relations), « *Paléosociologie* » represented by François Bon and others, and « *Paléotechnologie* » represented by Éric Boëda and his students. This most recent phase is characterised by a return to the 'big questions' and narratives of the founding generation (Bordes, Leroi-Gourhan, Laplace), but this time through the lens of the 'technological approach.'**

III.5 **Additional visualisation data from Boëda (1988)**

This section gathers additional pictorial sources of evidence, taken from Boëda's original study on the lithic assemblage from Biache Saint-Vaast IIA, to illustrate and perhaps clarify some of the claims made in the second part of Chapter 5 (5.3.1).

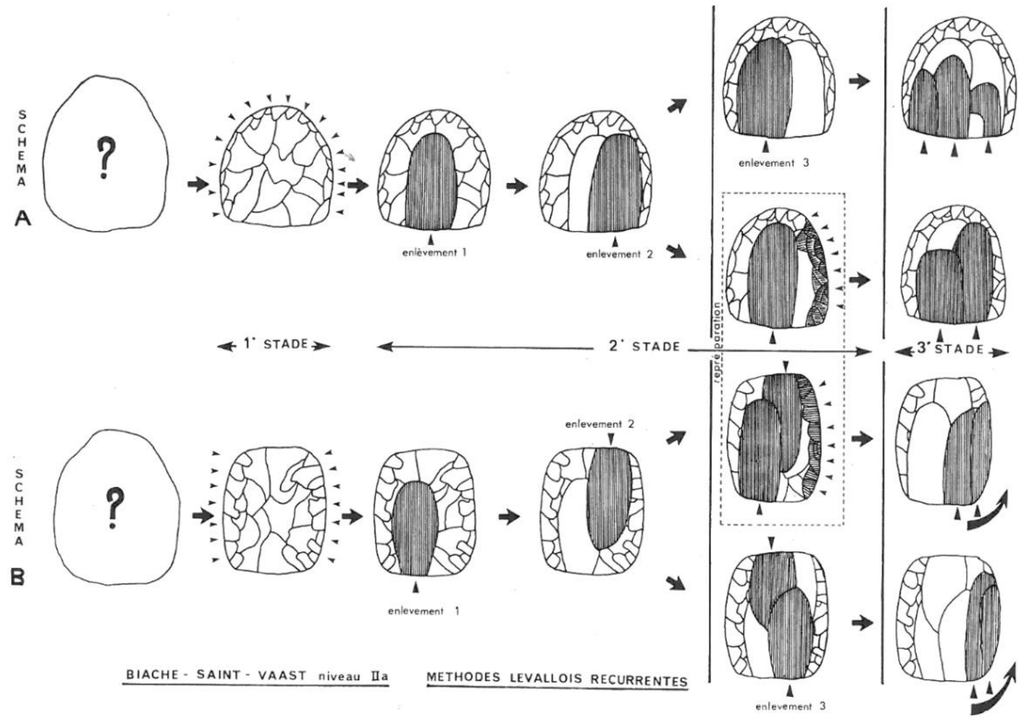


Fig. III.6 **Comparison of the temporal technical 'structures' of uni- and bidirectional methods of 'Levallois recurrent' (*Schémas A* and *B*) (Boëda 1988. Fig. 18.7). The visualisation of the unfolding of the two corresponding *chaînes opératoires* shows that each stage anticipates and determines its subsequent stage; the respective 'stages' are enchained, their order is fixed by the nature of each stage. Note in particular that different technical decisions have different effects on core organisation and thus drive reduction in a particular direction (especially 'early' decisions have non-proportionally high effects). As a result, core-surface convexities can be managed in different ways (cf. the treatment of almost depleted cores at 'Stage 3').**

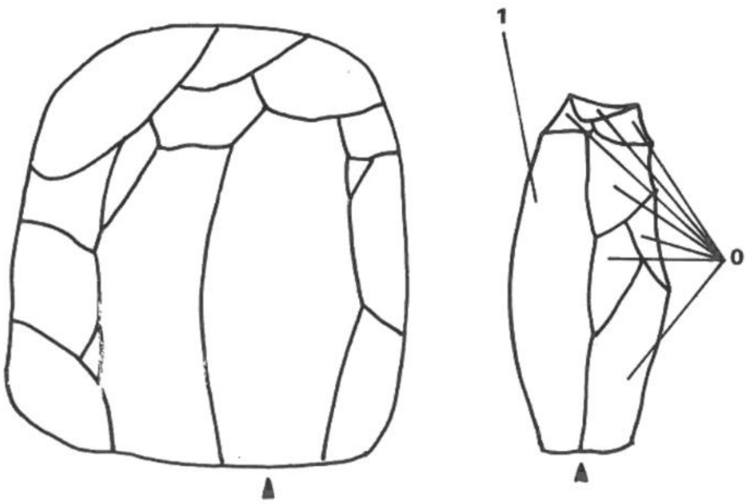


Fig. III.7 **Schematic illustration of technical the complementarity between an unidirectional 'Stage 2' Levallois core and its corresponding Levallois flake (Boëda 1988: Fig. 18.15). Note especially that the outlines of the flake-negative and the flake itself match and that the structure of preceding core removals is preserved in the structure of dorsal scars on the flake [0: aligned scar of the preceding Levallois removal; 1: centripetal scars of lateral convexity preparation]. The assessment of complementarity is necessarily *qualitative* and requires to take both lithic 'fragments' – flake and core – *as they are*, that is, to juxtapose them in their holistic constitution.**

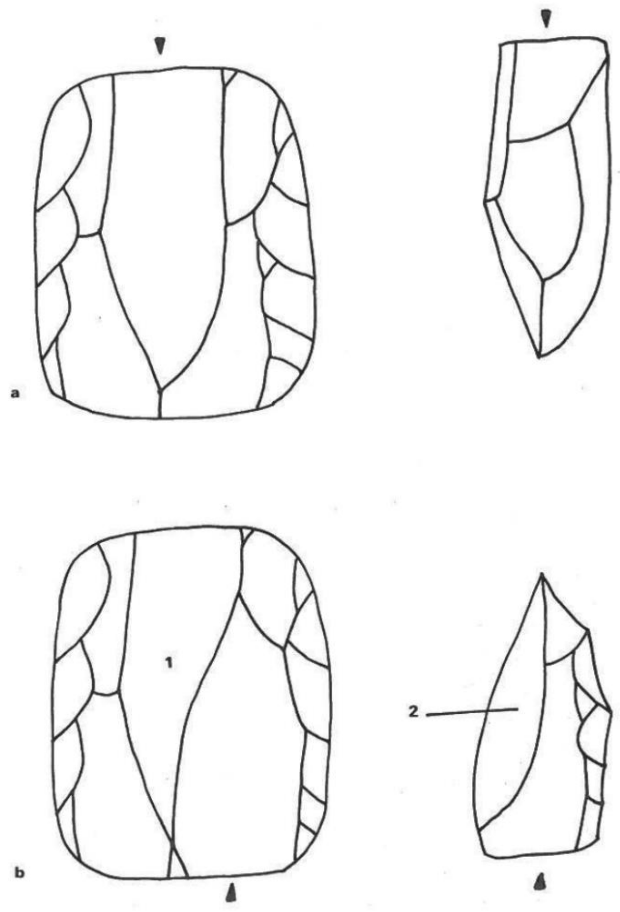


Fig. III.8 **Schematic illustration of the technical consequences of bidirectional 'recurrent' Levallois reduction (*Schéma B*) on the structure of dorsal scars on the corresponding Levallos flakes (Boëda 1988: Fig. 18.17). [a]: 'Detachment I,' [b] 'Detachment II.' Bidirectional 'recurrent' Levallois reduction generates asymmetric dorsal scar-patterns, exemplified by 'Detachment II;' the latter bears small perpendicular negatives form lateral convexity preparations (alternatively, flakes may conserve cortical *débordant* edges, see *ibid.*: Fig. 18.21) and large parallel negatives coming from the opposing direction.**

Appendix Q

List of original French quotes

The following original quotes, found in the literature in French, have been translated by the present author into English and are listed here in their original form for easy reference and for the sake of interpretive transparency. The English translations are provided in the main text. The order of quotes is the order of appearance in the text.

Q.1 Balandier (1974)

« [...] La seconde tentation pourrait être désignée comme celle de l' « ésotérisme ». Elle détache de l'ordre des réalités auquel elle substitue une construction logicienne, un édifice complexe de catégories, principes, notions et concepts auquel on n'accède que par initiation. La logique liant ces derniers est alors postulée identique à la logique du réel ; l'ordre des choses importe moins que l'ordre des mots. Et les critères de l'acquiescement deviennent à terme ceux de la foi, plus que ceux de la raison scientifique Cette tentation réalisée transforme les écoles scientifique en chapelles ou sectes, les controverses en débats scolastiques et les doutes en hérésies. » (Balandier 1974: 7f.)

Q.2 Perlès (1974)

« Si, grâce à [l'archéologie], nous connaissons de l'homme préhistorique quelques aspects de sa personne physique, de sa vie économique, artistique ou religieuse, c'est surtout sous l'angle du fabricant d'outils que l'homme de cette époque se révèle à nous. Bien souvent en effet, seule la pierre taillée demeure et témoigne de l'ancienne présence et des activités d'un groupe humain. De ce fait, l'outil de pierre acquiert une valeur considérable dans bien des domaines de la recherche préhistorique. » (Perlès 1974 : 816)

Q.3 Boissinot (2011)

« N'importe quel archéologue de bonne foi reconnaîtra en effet que l'interprétation qu'il donne des vestiges est une parmi bien d'autres plausibles ; qu'il faudrait pour bien faire entreprendre l'inventaire de tous les scénarios envisageables [...] Cette pluralité à considérer de front est en effet difficile à penser : l'esprit n'est pas préparé à traiter des informations aussi disparates, parfois contradictoires. Pour le dire en quelques mots, cette pluralité tient en partie au caractère fragmentaire des objets à considérer : le monde des restes est une totalité amputée selon des lois variées, celles du hasard n'étant pas négligeables. » (Boissinot 2011 : 267)

Q.4 Perlès (2016):

« [...] Ma conclusion, aujourd'hui, est l'inverse : je pense qu'au-delà de certaines convergences sémantiques, le divorce entre approche française et approche anglo-saxonne est profond, et que les divergences sont, en réalité, aussi profondes à l'heure actuelle qu'elles l'étaient lors des balbutiements des approches technologiques (lithiques) de chaque côté de l'Atlantique. » (Perlès 2016: 213)

Q.5 Bon (2009):

« [...] Surtout, l'essor démographique expliquerait en partie la redéfinition de fonctionnements sociaux. Cette perception est fortement influencée par la tradition anglo-saxonne, en particulier américaine, dont l'école néo-évolutionniste considéra de longue date la démographie comme l'un des principaux moteurs de la transformation des sociétés humaines. [...] Or parmi ces travaux, nombreux sont ceux qui jugent que ce facteur démographique est étroitement lié aux variations environnementales. Indépendamment de ses liens éventuels avec la démographie, le thème des conditions environnementales rejoint une vive préoccupation des écoles anglo-saxonnes, et leur influence est déterminante en ce domaine, tant dans l'affirmation de l'importance de ce thème que dans la façon de l'aborder. Depuis longtemps déjà, plusieurs de ces écoles articulent leur démarche intellectuelle autour de la recherche de modèles à portée générale : elles élaborent un modèle prédictif, le plus souvent inspiré par des situations contemporaines dont il convient de mesurer le degré d'application au contexte archéologique. Cette méthode repose sur le postulat que des comportements universaux sont susceptibles de transcender les barrières temporelles et d'être identifiés. Parmi ces universaux, l'accent est très souvent mis sur la relation de l'homme à son environnement au prisme déterminisme relativement strict. En d'autres termes, l'élaboration d'un modèle d'exploitation de l'environnement à partir de la confrontation de contextes ethnologiques actuels leur sert à interpréter les données archéologiques, dont la collecte leur permet de confirmer – ou non – une hypothèse préétablie. Cette orientation intellectuelle s'exprime notamment avec la *New Archeology*, créée dans les années 1960 selon ces principes. Cette approche hypothético-déductive s'oppose à la démarche la plus courante en Europe, et notamment en France, qualifiée d'inductive : la collecte des faits est censée précéder l'élaboration de modèles, et non répondre à une idée préconçue. » (Bon 2009: 119f.; original emphasis)

« […] Toutefois, une relation *mécanique* entre ces mutations environnementales et les changements d'équipements doit être envisagée avec prudence […] » (*ibid.*: 179; original emphasis)

« […] Toutefois, il n'existe pas d'équation unilatérale entre un type d'arme et un milieu donné. » (*ibid.*: 182)

« […] Toute société transparaît donc d'abord sous les traits de son adaptation à son environnement. Mais cette notion mérite d'être correctement évaluée : elle signifie, selon nous, l'adaptation à des conditions naturelles particulières de prérogatives sociales procédant d'une dynamique interne. En ce sens, ces contraintes naturelles œuvrent sur l'écorce d'une société, et non en profondeur. Ainsi, le fait de privilégier une démarche plus ou moins collective en matière de chasse, de promouvoir des technologies conférant aux équipements de chasse une place plus ou moins prépondérante, répondent à des impératifs sociaux indépendants des conditions du milieu naturel. De la même façon, ce n'est jamais l'environnement qui impose à un groupe humain de devenir agriculteur et pasteur mais une évolution propre à l'homme et à ses sociétés qui peut y conduire. Certes, le milieu peut faire obstacle à ou favoriser telle transformation comportementale, mais il s'agit dans tous les cas de façon passive. De telle sorte que l'environnement n'est pas une cause mais un moyen de cette évolution. Les expressions technologiques et économiques d'une culture se révèlent donc l'alliage de déterminants externes et de déterminismes internes parfaitement indépendants de ces derniers. » (*ibid.*: 243)

« […] Mais l'important est de percevoir l'articulation de ces divers domaines – économique, technique, religieux – autour de la structure idéologique qui fait d'un groupe humain une véritable société humaine. Et cela sans partir du présupposé que les domaines les plus accessibles, comme ceux relevant de l'identité techno-économique d'une population donnée, agissent sous la forme d'un déterminant plus puissant que d'autres composantes de cette société. » (*ibid.*: 324)

Q.6 Marchand (2014):

« Sa [la *New Archeology* de Binford] conséquence dans l'étude du Mésolithique européen au cours des années 1980 et 1990 a été – hélas – l'inévitable conclusion de tous les articles sur la société adaptée à son environnement et sur le site placé à la croisée de niches écologiques diversifiées… La déformation des principes de l'archéologie processuelle, pourtant autrement fructueuse, entraînait finalement les recherches sur les chasseur-cueilleurs du passé dans une dimension sans histoire : un comble ! De fait, la notion d'adaptation ne doit pas être appliquée sans chercher les moyens de la démontrer, sinon elle conduit à une vision figée des changements [Bettinger 1987]. » (Marchand 2014: 103)

Q.7 Marchand (2017):

« Je fais partie des rares archéologues qui pensent – et espèrent – qu'un jour, une bonne part des travaux sur la préhistoire pourra être livrée exclusivement en images, en dessins et en schémas. » (Marchand in Mevel 2017: 10)

« Qu'est-ce qui impulse ces changements perceptibles dans la culture matérielle ? Comment s'est opérée cette mutation sur le substrat magdalénien ? […] Les liens entre d'une côté les bouleversements climatiques et écologiques du Tardiglaciaire, et de l'autre ces mutations substantielles des symboles et des techniques, siègent bien évidemment au cœur de tous les débats [...]. » (*ibid.*: 9)

Q.8 Tixier (1978):

« [...] J'ai délibérément écarté la voie de la typologie fonctionelle. C'est faute de données sur le comportement des hommes préhistoriques à travers leurs activités avec leur outils, faute de pouvoir, encore à l'heure actuelle, discerner les intentions d'utilisation, que je me suis attaché à saisir les intentions de taillée. [...] Pour qu'un terme soit précis, sans equivoque, il doit contenir en lui-même l'intention de l'artisan qui a taillé un outil préhistorique. » (Tixier (1978 [2012]: 115, 117)

Q.9 Ploux (1988):

« [...] [C]hacun des artéfacts issu d'une même ensemble a un destin potentiellement différent. Cette situation ménage donc la possibilité de mettre en évidence les inter-actions entre chaque processus technique – au mieux identifiable à partir d'un grattoir dont les micro-traces d'usage indiquent le travail de la peau, d'un burin ayant travaillé le bois animal, etc. – et chaque chaîne technique. [...] En réalité, une multitude de modalités est envisageable, selon que le schéma d'inter-action établit une correspondance entre un processus et une ou plusieurs chaînes, que chaque chaîne participe ou non à plusieurs processus, qu'à l'intérieur d'une même chaîne, les mêmes artéfacts interviennent successivement dans plusieurs processus, soit sous la même forme, soit après transformation. À l'échelle d'un assemblage, toutes ces modalités ou seulement certains d'entre elles peuvent être représentées, illustrant des attitudes fort différentes vis-à-vis de l'organisation des activités techniques. L'importance de ce type d'informations a d'ailleurs été soulignée plusieurs fois [...] » (Ploux 1988: 39)

« [...] [Le] déroulement [de la *chaîne opératoire*] se présentant comme un enchaînement de moyens organisés dans le temps et dans l'espace, la chaîne technique peut être découpée en séquences opératoires spatiotemporelles » (*ibid.*: 41).

Q.10 Boëda (1986):

« La pointe Levallois peut résulter de conceptions de taillée différentes qu'une détermination simplement typologique ne permet pas de mettre en évidence. Seule l'analyse technologique des connaissances mises en jeu pour sa réalisation peut montrer la variabilité potentielle des conceptions volumétriques des nucléus et des méthodes qui en resultant. » (Boëda 1986: 263)

Q.11 Pelegrin (1995):

« [...] Il faut alors faire appel à ce qui pourrait s'appeler le *remontage mental* : 1'étude de chacun des objets lithiques, selon sa morphologie, la présence et position du cortex, l'ordre et 1'aspect des négatifs d'enlèvements (visibles tant sur les enlèvements que sur les nucléus : observation de schémas diacritiques) témoins d'une brève séquence antécédente, peut permettre, en les resituant mentalement les uns par rapport aux autres et par rapport au bloc brut, de reconstruire l'agencement ordonné dont ils sont les restes (notion essentielle formalisée par J. Tixier 1978). [...] Une telle opération mentale, qui réoriente les pièces dans les trois dimensions de 1'espace et selon 1'ordre de leur détachement, s'appuie sur une « logique technique » qui demande une bonne pratique de 1'étude de collections et profite toujours d'une expérience de la taille des roches dures (cf. la *lecture technologique* des pièces lithiques : J. Tixier *et al.*, 1980, p. 35) » (Pelegrin 1995: 23f., original emphasis changed from bold to italics).

Q.12 Renard and Ducasse (2015):

« [...] nous avons pris le parti d'une présentation « intégrée » et qualitative des données en opposant deux ensembles : le Solutréen récent d'un côté (c.-à-d. Solutréen à pointes à cran) et le Badegoulien de l'autre (c.-à-d. Badegoulien ancien et récent). Les hypothèses ainsi proposées reposent sur une vision synthétique « moyennée » de chacun de ces ensembles, nécessaire à une mise en perspective la plus large possible » (Renard and Ducasse 2015: 195)

« Le statut de chacune de ces productions [lithiques] est donc défini au regard de l'ensemble du système technique lithique afin de juger de l'investissement techno-économique qui leur est respectivement conféré ainsi que de leur niveau de dépendance réciproque (intégration ou disjonction des objectifs, « hiérarchie » économique). Les productions lithiques solutréennes et badegouliennes ont ainsi pu être comparées terme à terme afin de mesurer leur degré d'affinité techno-économique. » (*ibid.*: 194)

« [...] l'approche techno-économique montre qu'entre Solutréen et Badegoulien, c'est la structuration même du système technique qui semble avoir subi de profondes modifications. Le Badegoulien du Sud-Ouest français apparaît en effet comme un moment de refonte de l'architecture techno-économique du système de production et de gestion des équipements lithiques [...]. Cette refonte se traduit notamment par un nouveau rapport économique entre outillage domestique et armes de chasse, nouvel équilibre dont nous proposons d'explorer les corrélats en termes d'organisation spatio-temporelle des activités » (*idem*)

Q.13 Pelegrin (2011):

« Le point important, que je souhaite souligner ici, est ce que l'articulation de la méthode de taille avec les outils et restes bruts permet non seulement d'établir les règles de gestion : quelles classes morphologiques de support se retrouvent dans telles classes d'outils ; mais aussi de percevoir la ou les priorités sous-jacentes à ces règles de gestion. On peut alors passer de la diversité des méthodes de taille à la diversité techno-économique du système lithique. » (Pelegrin 2011: 146)

Q.14 Valentin (1995):

« [Le système technique] résulte des relations fonctionnelles entre les différentes parties constitutives qui peuvent être considérées comme des sous-systèmes. Le fonctionnement peut être défini non pas uniquement par les 'lois de relations internes' de la production lithique mais aussi par la prise en compte de sa finalité, c'est à dire de sa fonction [c'est nous qui soulignons], notions complémentaires et intégrées [...]. Une production lithique est donc à la fois organisée par ses relations avec les autres sous-ensembles du système technique, par sa finalité (fabriquer des outils est la plus évidente), et par ses moyens (matériels et intellectuels). » (Valentin 1995: 24)

« Cette démarche impose une reconstitution fidèle des objectifs assignés à la chaîne opératoire ainsi qu'une appréciation fine des circonstances de sa réalisation ("*l'espace du possible*"). Quand ces circonstances sont correctement appréciées, le préhistorien est en mesure d'évaluer si telle ou telle modalité est l'unique réponse obligée dans une situation donnée (quand "*l'espace du possible est fermé*" [Pelegrin 1995]) ou s'il s'agit d'une des solutions envisageables parmi un ensemble d'options possibles. C'est une évaluation difficile, qui fait appel nécessairement à une compréhension globale de la chaîne opératoire [...]. » (*ibid.* : 27, original italics).

Q.15 Perlès (1988):

« Dans tout ensemble archéologique, il existe des pièces (combinaisons d'attributs) ou des attributs (techniques de fabrication, formes, matières premières, etc.) considérés comme caractéristiques de cet ensemble [...]. C'est pour mettre clairement en évidence [des] différences (ou ressemblances) que le préhistorien élabore une typologie, ou utilise une typologie déjà existante. Lors de l'élaboration d'une typologie, fondée sur des groupes de pièces (combinaisons complexes d'attributs), on opère nécessairement une hiérarchisation des caractères [...]. Une typologie est donc très différente d'une classification puisque chaque pièce pourrait, à strictement parler, appartenir à plusieurs types [...]. Mais c'est le propre d'une typologie de mettre en exergue les caractères qui permettent de résoudre des problèmes archéologiques précis [...]. En principe, une typologie devrait être conçue en fonction du problème posé (qui dicte le choix des caractères pertinents), et plusieurs typologies pourraient être appliquées au même ensemble pour résoudre des problèmes différents. [...]Quel qu'en soit à nos yeux l'intérêt, une classification exprimera toujours une structure réelle du matériel étudié, puisqu'elle est fondée sur des propriétés intrinsèques de celui-ci. C'est là une des différences avec une typologie où l'on choisit au contraire de privilégier certains caractères, de les hiérarchiser en fonction du problème pose. » (Perlès 1988: 1080; cited after Valentin 1995: 2, footnote 2)

Q.16 Cresswell (1976):

« Les chaînes opératoire techniques ont deux caractéristiques essentielles : une cohérence interne, et une relation organique avec la structure sociale. » (Cresswell 1976: 6)

Q.17 Boëda (1988):

« [...] Ils [les tailleurs de Biache Saint-Vaast (niveau IIA)] étaient, semble-t-il, prisonniers des limites inhérentes à la conception volumétrique du nucléus Levallois, qui fixe à chacune des deux surfaces une fonction bien précise. » (Boëda 1988: 191f.)

« [...] L'étude des nucléus doit être première. Le nucléus est le plus important vecteur d'informations pour déterminer le concept de taille utilisé, de plus il porte en lui les stigmates de la ou des méthodes et techniques utilisée. L'analyse des éclats prédéterminants et prédéterminés est seconde : c'est de cette étude que sera définitivement déterminée la ou les méthodes employées par le tailleur. Cette articulation méthodologique entre nucléus et éclats doit évidemment tenir compte des capacités d'information fournies par les artefacts d'un gisement. » (*ibid.*: 1985).

Q.18 Perlès (1998):

« Mais il y a là un double problème : en premier lieu, ni l'échelle de temps ni la nature du temps sont les mêmes selon que l'on observe les changements climatiques (cycliques), l'évolution des végétaux (linéaire et très lente), l'évolution des faunes (linéaire elle aussi mais nettement plus rapide)... Il n'y a pas <u>un</u> temps de la préhistoire, qui sont pertinent pour tous les phénomènes étudiés, *a fortiori* pour les phénomènes humains. En second lieu, les causes de changement ne sont pas non plus les mêmes : ni les variations de l'orbite terrestre, qui sont à l'origine des cycles climatiques, ni les lois de la reproduction sexuées, à l'origine des transformations des espèces biologiques, ne peuvent prétendre expliquer l'« évolution des bifaces » ou le passage d'une économie de prédation à une économie de production. Il existe donc bien un camp de réflexion autonome, celui du « temps culturel », de sa nature et de ses rythmes. » (Perlès 1998: 17f., original emphasis)

Q.19 Valentin (2008a):

« Lent ou rapide, calme ou heurté, le rythme possiblement changeant de cette histoire préhistorique reste à mesurer beaucoup plus finement, et les circonstances de ses soubresauts éventuels méritent plus d'explications. C'est cela que vise l'ambition paléohistorique quand elle est fermement épaulée par la palethnologie. » (Valentin 2008: 28f.; also cited in Bon 2009: 185)

Q.20 Valentin (2011):

« [...] Il reste que ce découpage du Paléolithique récent rend imparfaitement compte des variations régionales et historiques, et surtout des transitions s'opérant à des rythmes différents non seulement selon les régions mais aussi selon les domaines d'invention. » (Valentin 2011: 31)

Q.21 Godelier (2007):

« [L]'homme n'est pas seulement un être qui s'adapte, il est un être qui s'invente. C'est un être qui ne peut pas vivre en société sans se donner ou recevoir dès sa naissance la capacité de produire de la société pour vivre. » (Godelier 2007: 189)

Q.22 Boëda (2013):

« [...] Les arguments sont à rechercher dans la cohérence du système technique par l'approche techno-fonctionnelle et non pas par la tracéologie qui ne fait que confirmer l'existence de l'emmanchements, sans nous informer de ses spécifités. » (Boëda 2013: 222)

« [...] De la même façon, dans le cas de Type Pyramidal E2, plusieurs méthodes permettent de produire uniquement des lames ou, au contraire, une mixité technique composée de lames de d'enlèvements triangulaires dont des pointes dites Levallois. En revanche, dans le cas du discoïde comme du pyramidal, la direction des enlèvements n'a pas de valeur de différenciation de méthodes. En effet, pour que l'exploitation d'un premier volume utile conduise à un second volume utile, il faut, dans le cas de discoïde, nécessairement employer des enlèvements de différentes directions, et, dans le cas du pyramidal, des enlèvements de même direction. Les directions changeantes ou uniformes relèvent nettement plus d'une nécessité structurelle que de l'expression d'un caractère culturel, à l'opposé de ce que l'on verra pour le nucléus Levallois et certains nucléus laminaires du Paléolithique supérieur. » (*ibid.*: 146)

« La technique, au même titre que la magie ou la religion, est une façon d'être au monde. Cette évaluation culturelle de la réalité technique passe par l'investigation de la nature technique de l'objet, en repensant l'objet à travers sa technicité et en reconsidérant l'objet technique dans une couplage structurel avec l'Homme, lui-même en devenir. Cette notion de couplage implique nécessairement une coévolution de l'Homme et de la technique cette dernière étant régie par des « lois d'évolution ». » (*ibid*.: 28)

« Si nous pouvions nous dépouiller de tout orgueil, si pour definer notre espèce, nous nous en tenions strictement à ce que l'histoire et la préhistoire nous presentment comme la caractéristique constant de l'homme et de l'intelligence, nous ne dirions peut-être pas *Homo sapiens*, mais *Homo faber*. » (Bergson 1959: 613, cited by Boëda [2013: introductory citation] and original emphasis)

English summary

In 1959, the British scientist and novelist Charles P. Snow caused an uproar when delivering his now famous Rede Lecture: *The Two Cultures*. He argued that 'the intellectual life of the whole of Western society' is divided by two cultures of thought. These 'two cultures,' he contended, can be characterised as co-existing, but mutually estranged spheres of knowledge production and knowing. They, he insisted, tend to know very little about each other, typically dislike each other, and are inclined to exchange hostilities and basic criticism. In recent decades, a similar chasm has become more and more apparent within Old World Palaeolithic archaeology. This field is also torn apart between two 'cultures' of research: the French tradition on the one hand, and Anglophone research, primarily represented by American and British scholarship on the other. The discord between the two dates back at least to the 'Binford-Bordes debate,' but has taken even clearer shape in recent years. Whereas French research is traditionally rooted in the humanities, especially history and ethnology, Anglophone research models itself increasingly on the natural and life sciences, especially ecology, biological anthropology, and the larger field of evolutionary studies. This situation is, for instance, well reflected in the opposition between *« Palethnologie »* and *Paleoanthropology* – two largely incompatible visions of the discipline that play a key role in the development of Palaeolithic research on both sides.

In this dissertation, I take stock of this chasm between French and Anglophone research within the domain of lithic analysis. My focus is epistemological. I focus not so much on lithic data themselves, but on different ways of handling them. By comparing the latest French and Anglophone approaches to the lithic evidence, I assess the cognitive underpinnings of what we may call the 'French-Anglophone divide.' The main contention is that the divide, although occasionally touched upon in the expert literature, has hitherto not received the attention it deserves. I demonstrate that the conflict between French and Anglophone lithic research signifies a proper bifurcation of the research landscape and engenders mutually exclusive knowledge claims. The French-Anglophone interface is found to generate a steep cognitive threshold, predisposing scholars to cultivate antagonistic perceptions of the past, to organise research differently, to harness incompatible methodological and conceptual resources, and to participate in largely distinct discursive spaces. The divide is thus not only of scholastic interest or a matter of mere theoretical concern, but has tangible consequences for how lithic research is undertaken and what its possible outcomes are.

My analysis proceeds in four steps. First, I take stock of the available literature that directly or indirectly gives voice to the divide and place it into the wider context of lithic knowledge formation in Palaeolithic archaeology. Secondly, I introduce American philosopher Stephen C. Pepper's framework of world hypotheses and develop a conceptual toolkit to effectively compare lithic practice in both research spheres. Thirdly, I apply the derived concepts to selected cases deemed representative of French and Anglophone lithic inquiry. In a final step, I apply Pepper's notion of 'world hypotheses' to the divide and develop an argument for pluralism in lithic analysis.

The first part of **Chapter 1** outlines the problem of lithic knowledge and its relevance for Palaeolithic research. It is argued that lithic data carry a heavy burden since their abundance and sturdiness render them the primary foothold for picturing human behaviour in the deep past. But although much hinges on our ability to effectively interrogate this evidence, the record itself remains notoriously incomplete and scanty. This basic condition makes lithic knowledge generally vulnerable to underdetermination. Underdetermination occurs when multiple, yet incompatible interpretations are equally supported by the evidence. The social realities of research, moreover, often cloud the gravity of such issues. The dynamics of particular research communities tend to support a general tenacity of viewpoints, typically preventing practitioners from exploring alternative viewpoints or incentivising them to work around underdetermination by retreating to dogmatic positions. A classic symptom of conflicting research communities is that individual scholars have considerable difficulty respecting and understanding their counterparts – the two communities seem to relate to one another just like two ships passing in the night without even recognising the respective 'other.' The result is a trend to wage disputes as partisan and to regularly 'talk past each other.'

In the second part of **Chapter 1**, I review the evidence for serious misunderstandings and disagreements caused by the French-Anglophone boundary. It is shown that lithic experts from both camps tend to reject each other's most basic assumptions and are generally sceptical about the cognitive value of approaches on the 'other' side. The tone and rhetorical quality of the critique as well as the commonality of 'talking past each other' reveal deeply engrained hostilities and an inability to bridge the communicative gulf established by the divide. The confrontation of the prevailing characterisation of Palaeolithic research, its theoretical affinities, and its disciplinary identity confirms the presence of mutually exclusive orientations of inquiry. The disparity is also echoed in the institutional framing of lithic research and the dominant pathways of disseminating its findings. But although the critique is equally resolute and poignant on both sides, there is a clear asymmetry of negotiating it in press. While some Anglophone scholars have openly addressed the apparent chasm of approaches, French experts have only rarely responded to these calls and tend to deal with the divide more indirectly, preferably in monographs where one's own approach can comfortably be contrasted with rivalling research paradigms. To illustrate this general divergence of lithic research traditions, I introduce three concrete cases of conflict in which French and Anglophone representatives have studied broadly the same lithic materials, but put forth irreconcilable interpretations of the evidence (to wit: Biache Saint-Vaast level IIA, Gouzeaucourt G, and Kulna's Micoquian layers). The analysis of these cases supports the idea that the French-Anglophone divide expresses a basic problem of underdetermination.

Chapter 2 introduces Pepper's world hypotheses theory. The key proposition is that the history of Western thought can be broken down into a small number of world hypotheses: theories about the world specifying key assumptions and directing inquiry on a basic level. According to Pepper, only four of these theories have hitherto proven cognitive adequacy. These theories are 'formism,' 'contextualism,' 'mechanism,' and 'organicism.' They represent equally well-supported perspectives on the world and 'how it generally hangs together.' Each world theory supplies a distinct canon of structural categories, subscribes to varying bodies of method and theory, promotes different kinds of data, and relies on a specific mode of knowledge corroboration not shared by the other world theories.

Pepper's four relatively adequate world theories can be divided into two groups of two. The first distinction is between 'analytic' and 'synthetic' theories. The former emphasise the priority of parts and presuppose that wholes are derived features of the world. The latter, by contrast, defend the prerogative status of wholes and insist on the whole-dependency of parts. The second distinction is between 'integrative' and 'dispersive' theories. Whereas the former assume that the world is a highly determined place and typically focus on a few constitutional relationships, the latter recognise the world as a weakly determined place and seek to account for as many facts at the same time as possible. 'Formism' and 'mechanism' are 'analytic' world theories, while 'contextualism' and 'organicism' are the 'synthetic' ones. Likewise, 'formism' and 'contextualism' are 'dispersive' theories, whereas 'mechanism' and 'organicism' uphold the banner of 'integrativity.'

These world theories are insular, cannot be reduced to one another, and endorse different sets of cognitive values. Yet, each theory is also fallible and contains an 'ulcer of self-contradiction.' The implication is that although all four theories enable highly adequate readings of the evidence, all of them are also likely to furnish merely an incomplete picture of whatever they investigate. Each theory pictures the world differently, but none can be elevated above all others.

Chapters 3 to **5** apply world hypotheses theory to seminal cases of lithic research, testing the intuition that French lithic inquiry is based on 'synthetic' understandings of technology while Anglophone approaches tend to process lithic data 'analytically.' The demonstration proceeds in several steps. Chapter 3 lays out some of the most basic, yet perennial differences between French and Anglophone lithic approaches and shows that these can be considerably clarified by mapping them onto the 'analytic'-'synthetic' dichotomy. The cognitive value of this separation is demonstrated by comparing the logic of lithic recording, the nature of research design and inference-making, the role of theory and data, and the preferred modes of visualisation in both research spheres. As a final case in point, diverging interpretations of variability and complexity in lithic research are examined.

In **Chapter 4**, it is shown that Anglophone approaches disintegrate into 'formistic' and 'mechanistic' branches of investigation. The ramifications of 'formism' are illustrated by four case studies: (f-i) Scerri et al.'s multivariate analysis of North African MSA technology; (f-ii) Conard et al.'s proposition of a simplified core taxonomy for studying technological variability in the African Stone

Age; (f-iii) morphometric and phylogenetic perspectives to the lithic data championed, among others, by Lycett and Archer et al.; and (f-iv) the longstanding debate on handaxe symmetry in British Palaeolithic research. The reliance on 'mechanism' is showcased by three similarly diagnostic cases: (m-i) Henry's dimensional approach to lithic reduction; (m-ii) Dibble's scraper reduction model put forth to explain interassemblage variability in the European Mousterian; and (m-iii) the wider discourse on technological adaptation and the ecological role of lithic artefacts. All of these examples illustrate that lithic inquiry in the Anglophone world is anchored by concepts that are ultimately furnished by the 'analytic' world theories.

Chapter 5 discloses French lithic research as an interplay between 'contextualistic' and 'organicistic' strands of inquiry. The 'contextualistic' underpinnings of many French approaches are revealed through the examination of four case studies: (c-i) the 'technological approach' and its reliance on 'lecture,' 'mental refitting,' and the deployment of the *schéma diacritique*; (c-ii) Renard and Ducasse's interpretation of structural differences between the lithic technologies of the Developed Solutrean and the Badegoulian of South-Western France; (c-iii) the techno-economic paradigm and its interpretive approach to raw material economy and mobility; and (c-iv) the role and meaning of lithic types in French technological research. The French dependence on 'organicistic' categories is revealed through the examination of three equally striking cases: (o-i) Boëda's original interpretation of 'Levallois recurrent'; (o-ii) *« Paléohistoire »* and its insistence on multiple temporalities and conflicts of evolutionary becoming; and (o-iii) the 'techno-genetic' paradigm and its analysis of 'technical lineages.' The investigation of these test-cases confirms that French approaches tend to rely on a 'synthetic' grasp of the lithic evidence.

Chapter 6, finally, reviews the main findings and discusses their implications. I conclude that the divide is indeed complete, affects all levels of inquiry, and can therefore hardly be ignored. The insights gained from the preceding examination permits the reinterpretation of the key axes of divergence in the light of Pepper's world hypotheses. This not only enhances our understanding of the difficulties that French and Anglophone practitioners face when they engage with one another, but also allows the identification of hitherto unrecognised points of friction. Analysing the French-Anglophone divide in terms of Pepper's structural categories allows us to gauge the cognitive bearing of underdetermination in lithic inquiry. However, the key point is that all of the clashing approaches need to be respected for what they offer: adequate perspectives to an inherently problematic record. Since these perspectives are equally fallible yet cognitively distinct, no singular viewpoint can reasonably claim superiority. To discard any of the involved cognitive tendencies would be dogmatic and is simply unaffordable if we wish to profit from the broadest possible base of lithic evidence.

This reconstruction of the French-Anglophone divide suggests that (i) a 'pluralistic stance' in lithic research is required and that (ii) a more balanced, but nonetheless critical attitude towards cognitive 'others' should be cultivated. Instead of waging knowledge-conflicts as partisan, practitioners should acknowledge the cognitive 'other' as a proficient expert rather than a misguided competitor. A re-consideration of 'critical practice' in the field is thus long overdue. By revisiting the disputes and interpretive divergences between French and Anglophone researchers enumerated in Chapter 1, it is demonstrated that criticism at the French-Anglophone interface often misses its mark or fails to be effective because these basic lessons are currently not taken seriously enough. I conclude that an honest *rapprochement* between the two research spheres is only possible if we come to accept divergent viewpoints as *alternative* and keep the conversation going. The chapter brings the analysis to a close by outlining some possibilities of how this may be achieved.

Nederlandse samenvatting

In 1959 zorgde de Britse wetenschapper en schrijver Charles P. Snow voor tumult bij het uitspreken van de beruchte rede *The Two Cultures*. Hij argumenteerde dat 'het intellectuele leven van de hele westerse samenleving' is opgesplitst in twee sterk verschillende denktradities. Deze 'twee culturen', zo stelde hij, kunnen worden aangemerkt als twee co-existerende, maar van elkaar vervreemde gebieden van kennis en kennisproductie. Volgens Snow weten ze weinig van elkaar en hebben ze een hekel aan elkaar. Over en weer uiten ze vijandelijkheden en kritiek.

De afgelopen decennia tekent zich een vergelijkbare kloof af binnen de paleolithische archeologie. Ook hier zijn er twee 'onderzoeksculturen': de Franse traditie en de Engelstalige traditie - waarbij de laatstgenoemde grotendeels vertegenwoordigd wordt door Amerikaanse en Britse wetenschapsbeoefening. De onenigheid gaat ten minste terug tot het 'Binford-Bordes debat', maar is de laatste jaren steeds duidelijker geworden. Terwijl Frans onderzoek traditioneel geworteld is in de geesteswetenschappen, in het bijzonder geschiedenis en etnologie, modelleert het Engelstalig onderzoek zich steeds meer naar de natuur- en levenswetenschappen, met name ecologie, biologische antropologie en evolutionaire studies. De huidige status quo blijkt onder meer uit de tegenstelling tussen *palethnologie* en *paleoanthropology*. Twee grotendeels onverenigbare visies op de discipline spelen een sleutelrol in het paleolithisch onderzoek.

Deze studie richt zich in het bijzonder op verschillen tussen Franse en Engelstalige lithische analyse. De invalshoek is epistemologisch: niet primair gericht op de lithische data zelf alswel op twee verschillende manieren waarop daarmee wordt omgegaan. Recente Franse en Engelstalige strategieën van lithische analyse worden vergeleken teneinde de respectievelijke cognitieve onderbouwingen zichtbaar te maken. In de vakliteratuur zijn deze onderbouwingen tot nu toe niet serieus genoeg genomen. Er is sprake van strijdige kennisclaims. De betreffende wetenschappers zijn geneigd antagonistische standpunten over het verleden in te nemen; onderzoek anders te organiseren; onverenigbare methodologische en conceptuele hulpmiddelen in te zetten; en te opereren in goeddeels gescheiden discursieve ruimtes. De kloof is dus niet alleen een kwestie van puur scholastieke interesse of een theoretisch dispuut, maar heeft tastbare gevolgen voor de manier waarop lithisch onderzoek wordt uitgevoerd en wat de mogelijke uitkomsten zijn.

De analyse van deze fundamentele divergentie vindt plaats in vier stappen. Ten eerste wordt de literatuur geïnventariseerd die deze splitsing direct of indirect uitdrukt. Ten tweede wordt de filosoof Stephen C. Pepper geïntroduceerd met zijn raamwerk van "wereldhypothesen". Met dit conceptueel apparaat kunnen lithische praktijken in beide onderzoekssferen doeltreffend vergeleken worden. Vervolgens, ten derde, wordt dit apparaat toegepast op representatieve casussen uit beide tradities. In een laatste stap wordt de Frans-Engelstalige kloof geëvalueerd in termen van Peppers wereldhypothesen en worden enkele implicaties ontwikkeld voor pluralisme in lithische analyse.

Het eerste deel van **hoofdstuk 1** schetst de problemen die bij lithische analyse optreden en hun relevantie voor paleolithisch onderzoek. Men denkt veelal dat lithische data, vaak in overvloed aanwezig, een robuust houvast biedt voor de reconstructie van gedrag in het verre verleden. Hoewel veel afhangt van ons vermogen dit bewijsmateriaal effectief te ondervragen is het archeologische bestand echter notoir onvolledig en beperkt. Hierdoor is lithische kennis algemeen gesproken kwetsbaar voor ontoereikende bewijsvoering. Hiervan is sprake wanneer meerdere, met elkaar onverenigbare interpretaties even sterk door het bewijsmateriaal worden ondersteund. Bovendien vertroebelt de sociale werkelijkheid het van onderzoek vaak het zicht op de ernst van zulke kwesties. Gemeenschappen van onderzoekers neigen ófwel ertoe vast te houden aan de eigen standpunten en alternatieve gezichtspunten niet te onderzoeken ófwel onbepaaldheid te vermijden door een dogmatische positie in te nemen. Symptomatisch is het gebrek aan respect van individuele wetenschappers voor hun tegenhangers. De gemeenschappen van onderzoekers lijken zich te verhouden als *two ships passing in the night*, zonder de ander zelfs maar te herkennen. Ze vechten geschillen uit als partizanen en praten doorgaans langs elkaar heen.

In het tweede deel van hoofdstuk 1 worden enkele serieuze serieuze misverstanden en meningsverschillen besproken die samenhangen met de Frans-Engelstalige kloof. Lithische experts uit beide kampen neigen ertoe over en weer elkaars meest basale aannames te verwerpen. Ook zijn ze over het algemeen sceptisch over de waarde van 'andere' benaderingen. Hun toon, hun retoriek en hun langs elkaar heen praten laten een diep gewortelde vijandigheid zien jegens de andere traditie. Er lijkt sprake te zijn van een fundamenteel onvermogen tot communiceren, ook in desbetreffende institutionele kaders en wat betreft de gebruikelijke routes voor het verspreiden van bevindingen.

Hoewel de kritiek over en weer even resoluut en fel is overheersen Engelstalige woordvoerders. Een aantal van hen heeft genoemde kloof openlijk aangekaart. Franse experts daarentegen hebben maar zelden op oproepen gereageerd. Ze gaan veel indirecter met de situatie om, bij voorkeur via monografieën waarin zij hun eigen benadering vergelijken met rivaliserende onderzoekparadigma's. Ter illustratie worden drie concrete conflictgevallen besproken waarin Franse en Engelstalige vertegenwoordigers in grote lijnen hetzelfde lithische materiaal hebben bestudeerd, maar onverenigbare interpretaties geven - Biache Saint-Vaast niveau IIA, Gouzeaucourt G en de Micoquian lagen van de Kulna grot. Geargumenteerd wordt dat de Frans-Engelstalige kloof samenhangt met een fundamenteel probleem betreffende ontoereikende bewijsvoering.

Hoofdstuk 2 introduceert Peppers theorie van "wereldhypothesen": algemene theorieën over de wereld die onderzoek op een basisniveau aansturen. Zijn idee is dat in de geschiedenis van het westerse denken een beperkt aantal wereldhypothesen bepalend was. Vier van deze theorieën hebben volgens hem stand gehouden, te weten 'formalisme', 'contextualisme', 'mechanisme' en 'organicisme'. Deze vier bieden gelijkwaardige, goed onderbouwde perspectieven op de wereld en hoe deze algemeen gesproken samenhangt. Elk van deze wereldtheorieën heeft een eigen canon van structurele categorieën; levert een eigen variëteit van methoden en theorieën; bevordert het verzamelen van een specifiek type gegevens; en vertrouwt op een specifieke vorm van kennisbevestiging, incompatibel zijn met die van andere wereldtheorieën.

De vier relatief adequate wereldtheorieën vallen uiteen in twee groepen van twee. Een eerste onderscheid betreft het verschil tussen 'analytische' en 'synthetische' theorieën. De eerstgenoemde benadrukken de prioriteit van delen en zien gehelen slechts als afgeleide kenmerken van de wereld. De laatstgenoemde daarentegen zien gehelen als primair en bezien delen enkel vanuit hun afhankelijkheid van een geheel. Het tweede onderscheid betreft het verschil tussen 'integratieve' en 'dispersieve' theorieën. De eerstgenoemde nemen aan dat de wereld in sterke mate gedetermineerd is en concentreren zich doorgaans op enkele intrinsieke relaties tussen delen. De laatstgenoemde zien de wereld als zwak gedetermineerd en trachten zoveel mogelijk feiten tegelijkertijd te verklaren. 'Formisme' en 'mechanisme' zijn 'analytische' wereldtheorieën, terwijl 'contextualisme' en 'organicisme' 'synthetische' theorieën zijn. 'Formisme' en 'contextualisme' zijn 'dispersief', terwijl 'mechanisme' en 'organicisme' 'integratief' zijn.

Deze wereldtheorieën zijn over het algemeen insulair, onherleidbaar tot elkaar, en ondersteunen nogal verschillende cognitieve waarden. Tevens is elke wereldtheorie feilbaar en bevat ze een 'gezwel van zelfcontradictie'. De consequentie is dat alle vier de theorieën adequate maar tevens, opmerkelijk genoeg, onvolledige lezingen van de data leveren. Elke wereldtheorie beeldt de wereld anders uit, en geen enkele steekt er met kop en schouders bovenuit!

In de hoofdstukken 3, 4 en 5 worden enkele doorsnee voorbeelden van lithisch onderzoek onderzocht vanuit Peppers epistemologie. Onderzocht wordt in welke mate Frans lithisch onderzoek gebaseerd is op een 'synthetische' visie op technologie, en Engelstalig onderzoek op een 'analytische' visie. Dit gebeurt in vijf stappen.

Hoofdstuk 3 beschrijft een aantal fundamentele, langdurige verschillen tussen Franse en Engelstalige lithische benaderingen in termen van 'synthetisch' versus 'analytisch'. Dit blijkt goed te werken. Concreet wordt gekeken naar de logica achter registratie van vuursteen, de aard van onderzoekvoorstellen, de stijl van redeneren, de rol van theorie en data, en de wijze van visualiseren. Vervolgens komen de sterk divergerende interpretaties van lithische variabiliteit en complexiteit aan de orde.

Hoofdstuk 4 laat zien hoe er bij Engelstalige benaderingen sprake is van 'formistische' en 'mechanistische' onderzoeksvelden. Varianten van 'formisme' worden geïllustreerd met vier gevalsstudies: (f-i) de multivariate analyse van Noord-Afrikaanse MSA technologie van Scerri *et al.*; (f-ii) een voorstel voor een vereenvoudigde kerntaxonomie bij het bestuderen van technologische variabiliteit in de Afrikaanse prehistorie van Conard *et al.*; (f-iii) morfometrische en fylogenetische perspectieven op lithische gegevens van onder anderen Lycett en Archer *et al.*; en (f-iv) het langdurige debat over de symmetrie van bifaciale werktuigen in Brits paleolithisch onderzoek.

De 'mechanistische' invalshoek blijkt bepalend in drie, onderling vergelijkbare diagnostische gevalsstudies: (m-i) Henry's dimensionale benadering van lithische reductie; (m-ii) Dibbles schraper-reductiemodel ter verklaring van de variabiliteit in vuursteenassemblages in het Europese Moustérien; en (m-iii) het bredere discours over technologische aanpassing en de ecologische rol van stenen werktuigen. Bij alle zes gevalsstudies blijkt hoe lithisch onderzoek in de Engelstalige wereld verankerd is in 'analytische' wereldtheorieën.

Hoofdstuk 5 reconstrueert de Franse traditie van lithisch onderzoek in termen van een wisselwerking tussen 'contextualistische' en 'organistische' onderzoeksvragen. De contextualistische onderbouwing van veel Franse benaderingen wordt blootgelegd in vier gevalsstudies: (c-i) de 'technologische benadering' met behulp van 'lezing', 'mentale terugplaatsing' en het inzetten van het *schéma diacritique;* (c-ii) Renard en Ducasse's interpretatie van structurele verschillen tussen lithische technologieën van het latere Solutréen en het Badegoulien van zuidwest Frankrijk; (c-iii) het techno-economische paradigma en de interpretatieve benadering van grondstoffeneconomie en mobiliteit; en (c-iv) de rol en betekenis van vuursteentypes in Frans technologisch onderzoek.

De organistische inslag van Franse benaderingen komt vervolgens naar voren in drie opvallende gevalsstudies: (o-i) Boëda's oorspronkelijke interpretatie van 'Levallois récurrent'; (o-ii) de 'Paléohistoire' met haar nadruk op "meerdere temporaliteiten" en conflicten in evolutionaire genese; en (o-iii) de analyse van technische afstammingslijnen in het 'techno-genetische' paradigma. Duidelijk blijkt dat deze Franse benaderingen er een 'synthetisch' begrip van lithische bewijsmateriaal op na houden.

Inzichten uit de voorgaande hoofdstukken combinerend zet **hoofdstuk 6** tenslotte de bevindingen op een rij en ontwikkelt het enkele implicaties. De kloof tussen Frans en Engelstalig lithische onderzoek is radicaal en beïnvloedt alle niveaus van onderzoek. Meer begrip is vereist voor de problemen waarmee wetenschapsbeoefenaars uit de twee kampen worden geconfronteerd als zij met elkaar communiceren. De resultaten maken het ook mogelijk enkele tot nu toe niet onderkende punten van frictie te identificeren. Peppers epistemologie helpt zeer bij het omgaan met ontoereikende bewijsvoering in lithische analyse. De belangrijkste bevinding van dit proefschrift is dat alle conflicterende benaderingen moeten worden gerespecteerd voor wat ze te bieden hebben: adequate perspectieven op een inherent problematische archeologische bestanden. Deze perspectieven zijn in gelijke mate feilbaar. Geen van deze perspectieven kan redelijkerwijs superioriteit claimen over andere. Het opzij zetten van een ervan zou zonder meer dogmatisch en ondoordacht zijn als we streven naar de breedst mogelijke fundering voor lithische analyse.

De reconstructie van de Frans-Engelstalige divergentie suggereert dat een 'pluralistische houding' in lithisch onderzoek een vereiste is en dat een meer uitgebalanceerde, maar niettemin kritische houding tegenover 'anderen' moet worden gecultiveerd. In plaats van kennis-conflicten als partizanen uit te vechten zouden wetenschapsbeoefenaars de cognitieve 'ander' moeten erkennen als een bekwame expert in plaats van deze weg te zetten als een misleidende concurrent. Een heroverweging van de 'kritische praktijk' in het veld zoals hier ontwikkeld heeft lang op zich heeft laten wachten.

Als we de geschillen en verschillen tussen Franse en Engelstalige onderzoekers (Hoofdstuk 1) nu opnieuw bezien blijkt dat kritiek op het Frans-Engelstalige grensvlak vaak zijn doel mist of inefficiënt is omdat basisbeginselen niet serieus worden genomen. Een eerlijke *rapprochement* tussen de twee onderzoeksferen is alleen mogelijk als we de verschillende invalshoeken accepteren als gelijkwaardige alternatieven en proberen de dialoog gaande te houden. Tot besluit van dit onderzoek naar de Frans-Engelstalige kloof in lithische analyse worden enkele suggesties in deze richting gedaan.

Translated by Norbert Peeters
& Raymond Corbey

Acknowledgements

This work would not have been possible without the support, advice, and constructive criticism of my supervisors – Raymond Corbey, Marie Soressi, and Krist Vaesen. Their experience and differential viewpoints greatly helped me to balance my research and to sharpen my arguments.

I am thankful to Wil Roebroeks for accommodating me as a member of the Human Origins group at Leiden's Faculty of Archaeology.

There are many who provided useful comments over the years and I cannot do justice to all of them. The few that undoubtedly deserve being mentioned are Alexander Verpoorte, Mara-Julia Weber, Morgan Roussel, Olaf Jöris, Mathias Probst, Nathan Schlanger, Leonardo Carmignani, Gerrit Dusseldorp, Jürgen Richter, Thiemo Breyer, Marie Louise Herzfeld-Schild, and Johannes Schick.

Furthermore, I wish to express my gratitude to Prof. Catherine Perlès, Prof. François Bon, and John McNabb for their hospitality and willingness to discuss lithic matters with me.

Special credit goes to my fellow PhDs and friends in Leiden who made me feel at home in the Netherlands at all times, both socially and intellectually. Some of the most important peersons are: Femke Reidsma, Yoran Kremer, Nathalie Brusgaard, Andy Sorensen, Jordy Aal, Riia Timonen, Paul Kozowyk, Marcus Roxburgh, Roosmarie Vlaaskamp, Felix Poortman, Rik Semeijn, Bas Oostdijk, Robin Nieuwenkamp, Dafne Koutamanis, Emily Wilkes, and Igor Djakovic. I owe a great debt to Norbert Peeters for hassling with the intricacies and sometimes marginalities of my theoretical journey, as well as with the broadside of my complaints and at times intellectual frustrations.

Invaluable proofreading has been carried out by Allison Casaly, Lisa-Elen Meyering, Igor Djakovic, Marcus Roxburgh, Norbert Peeters, Jacob Börold, Carl Maier, Catrin Kost, and Daniel Turner.

This is also the place to pay tribute to the dealings of Gerrit Dusseldorp, my office co-dweller, for being a great workspace companion and securing a good amount of silliness within otherwise often 'sterile' daily routines.

In addition, I would like to thank my landlords, Thea and Ron, and their two cats, Sara and Pete, for the provided kindness and hospitality.

Last but not least, words are not enough to express my gratitude to Catrin, my companion and partner, for her love and continuous emotional support, as well as for her ability to withstand my sometimes erratic mood swings, especially in the final stages of manuscript completion.

Ideational and monetary support for this research has kindly been provided by the *Studienstiftung des Deutschen Volkes*.

CV

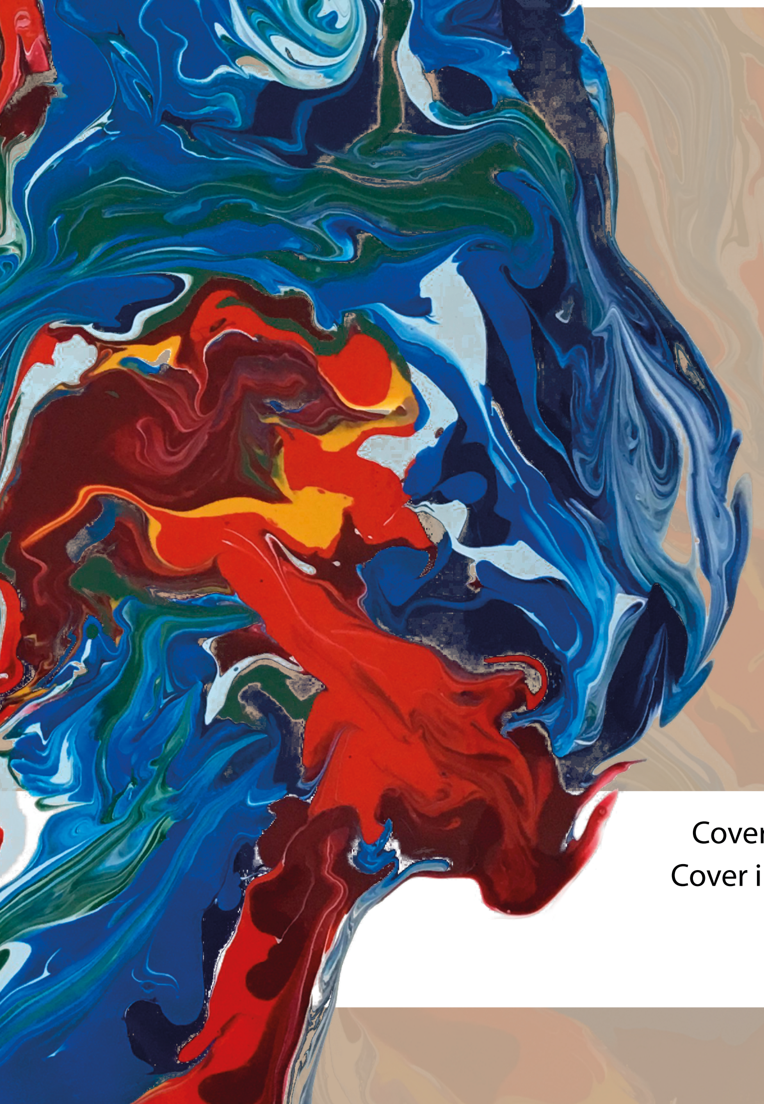
Shumon T. Hussain was born in Ostfildern, Germany on the 11th of August 1987. After finishing secondary school he moved to Tübingen to study Early Prehistory and Philosophy. In 2011, he received his BA from the University of Tübingen with a multidisciplinary thesis entitled *Homo empathicus - Versuch einer Evolutionären Anthropologie der Empathie*. This work has been awarded and was published in 2013 as a single-author monograph.

Shumon then moved to Cologne to continue his training in Palaeolithic archaeology. He specialised in lithic technology and participated in field projects in Germany, Austria, Jordan, and Saudi Arabia. He received his MA from the University of Cologne in 2013 with a thesis on selected lithic assemblages from the Early Upper Palaeolithic and Late Palaeolithic of the Wadi Sabra, Southern Jordan. The results of this project were published in 2015 as part of the multi-author volume *Pleistocene Archaeology of the Petra Area in Jordan*.

After having finished his MA, Shumon worked for the better part of a year as a junior research and teaching assistant at the Institute of Pre- and Protohistory in Cologne before obtaining a doctoral scholarship from the *Studienstiftung des Deutschen Volkes* and transferring to Leiden. In 2015, he joined the Human Origins group at the Faculty of Archaeology at Leiden University lead by Wil Roebroeks, and devised a research project on the theory and epistemology of lithic analysis. The present dissertation is the result of this research.

Shumon is the winner of the 2016 Student Award of the *European Association of Archaeologists* (EAA) and, in addition to his research on lithic technology and the epistemology of lithic research, has published a number of papers on hominin spatial behaviour, human-animal relations in the Palaeolithic, and the role of social cognition, especially empathy, in early human evolution. He is currently a visiting scholar at SUSTech in Shenzhen, Southern China.

In this provocative study, Shumon T. Hussain engages with the long-standing issue of French-Anglophone research conflicts in Palaeolithic archaeology. By examining a range of well-selected case studies and discursive contexts, the author shows that French and Anglophone approaches in stone artefact analysis are anchored in opposing cognitive frameworks. Hussain argues that the mainstays of this division can be elucidated by calling upon the marginalised work of American philosopher Stephen C. Pepper, who captured the totality of credible Western thought in terms of four equitable *world hypotheses*. Based upon his insights, the dissertation demonstrates that French lithic research gravitates towards 'contextualistic' and 'organicistic' modes of inquiry, while Anglophone lithic approaches tend to rely on 'formistic' and 'mechanistic' modes of reasoning. Shumon T. Hussain carefully lays out the implications of this condition for mutual understanding and critical practice. He contends that the French-Anglophone divide can only be overcome if scholars endorse *scientific pluralism* and begin to seriously take into consideration both the strengths and shortcomings of different cognitive frameworks, including their own.



Cover design by Kiron J. Hussain
Cover image by Wu Guandi 伍观弟
Schizophrenic biface
Acrylic on canvas, 2019